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Western Australian Methicillin-Resistant *Staphylococcus aureus* (MRSA) Epidemiology and Typing Report

July 1 2022 to June 30 2023

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1 Contents

2 Summary

Reporting period: 2022/2023:

- The number of non-duplicate MRSA referred to the Gram-positive Typing Laboratory in 2022/2023 was 8,473; a 6.4% increase compared to the 7,967 referred in 2021/2022.
- In Western Australia (WA), 10% (875/8,473) of MRSA were micro-alert C clones; the same proportion as seen in the previous reporting period (812/7,967, 10%).
- In the Perth Metropolitan health region micro-alert C MRSA accounted for 16% of MRSA.
- In each of the remote health regions (Kimberley, Pilbara, Goldfields and the Midwest), micro-alert C MRSA accounted for less than 4% of MRSA.
- The burden of MRSA colonisation/infection was highest in the Kimberley, Pilbara, Midwest and Goldfields health regions (3,290.9, 1,136.7, 801.5 and 725.1/100,000 population respectively).
- Panton-Valentine leucocidin (PVL)-positive MRSA were more common than PVL-negative MRSA in the following health regions: Kimberley (70% of MRSA), Pilbara (66%), Midwest (65%), Goldfields (52%), Wheatbelt (49%) and the Great Southern (57%).
- Although 26 PVL-positive clones were identified in WA, two PVL-positive clones dominated:
    - The Queensland (Qld) clone (ST93-IV [2B]) – 27% of all MRSA.
    - WA 121 (ST5-IV [2B]) – 14% of all MRSA.
- Significant increases or decreases in several clones were noted in the past year:
    - The Qld Clone increased in the Midwest (P=0.04) and the Great Southern (P<0.01).
    - WSPP MRSA increased in the Metropolitan (P=0.01), the Goldfields (P=0.01) and the Midwest (P=0.02)
    - WSPP MRSA decreased in the Kimberley (P<0.01)
- Last five years reporting period (2018/2019 to 2022/2023):
    - The number of micro-alert C MRSA decreased significantly in WA due to the decrease in UK 15 (P<0.01). The only micro-alert C clone to increase over the reporting period was PVL-positive ST22-IV [2B] (P<0.01).
    - In the Perth Metropolitan region PVL-positive ST22-IV [2B] and WA 121 increased (P<0.01) whilst UK 15, the Qld clone, WSPP MRSA decreased (P<0.01, P=0.26, P<0.01 respectively).
    - In the Kimberley region WA 121 increased (P<0.01) while the Qld clone and WSPP MRSA decreased (P<0.01).
    - In the Goldfields region WSPP MRSA increased (P=0.01) and the Qld clone decreased (P<0.01).
    - In the Midwest region UK 15 and WA 121 decreased (P<0.01 and P=0.1 respectively).

- In the Pilbara region WA 121 increased (P<0.01) whilst the Qld clone and WSPP MRSA decreased (P<0.01)
- No significant changes were detected in clone types in the Great Southern, Wheatbelt or South West.

3 Background

To prevent MRSA from becoming established in Western Australian acute care hospitals a statewide management policy was introduced in 1982. The mainstays of the program include a comprehensive and effective outbreak, identification and management policy. The incorporation of a central epidemiological typing laboratory that uses techniques to enable the rapid identification of MRSA clones has been pivotal in preventing MRSA from becoming established in Western Australian hospitals (1).

Since 1991, community-associated MRSA (CA-MRSA) clones have been associated with a dramatic ascent in the number of MRSA notifications and infections in WA and are increasingly recognized as a major cause of nosocomial-onset MRSA infections (2). However, the proportion of *S. aureus* nosocomial infections that are caused by CA-MRSA clones is similar to that found in the Western Australian community, suggesting CA-MRSA clones have not successfully found a niche in the Western Australian healthcare system but are imported from the community into hospitals (3).

In addition to distinguishing micro-alert C MRSA clones from micro-alert B MRSA clones the typing laboratory at Fiona Stanley Hospital PathWest-WA and the Antimicrobial Resistance and Infectious Diseases (AMRID) Research Laboratory at Murdoch University provides information on the emergence, transmission and evolution of novel MRSA in the Western Australian community (4; 5; 6; 7; 8; 9; 10; 11). Since 2010 there has been an exponential increase in PVL-positive CA-MRSA in WA; particularly in the remote health regions (12; 13). Of concern is the widespread emergence of the trimethoprim-resistant PVL-positive WA 121 (ST5-IV [2B]) clone. Having an understanding on the emergence of such clones has assisted in antimicrobial prescribing recommendations and patient health care (14).

4 Definitions

MRSA: methicillin-resistant *Staphylococcus aureus.*

Micro-alert B MRSA: An electronic tag applied to a patient record to indicate the patient has been infected with or colonised by a MRSA that is unlikely to spread in the healthcare environment.

Micro-alert C MRSA: An electronic tag applied to a patient record to indicate the patient has been infected with or colonised by a MRSA that either has the potential to spread in the healthcare environment or has increased virulence or transmissibility of antimicrobial resistance.

HA-MRSA: Healthcare-associated MRSA. MRSA that have adapted to the healthcare environment.

CA-MRSA: Community-associated MRSA. CA-MRSA emerged in the 1980s; typically found in patients without recent or frequent hospitalisation.

PVL: Panton Valentine leucocidin. PVL is a bi-component, pore-forming toxin that targets human macrophages, polymorphonuclear leukocytes and monocytes. PVL is associated with purulent skin and soft tissue infections but can also cause invasive disease. PVL-positive MRSA infections more frequently require surgical drainage or hospital admission than PVL-negative MRSA disease.

MLST: multi-locus sequence typing. A typing scheme that uses the sequences of seven housekeeping genes to determine an allelic profile. Isolates with the same sequence type (ST) are considered to be the same clone.

SCC*mec*: A chromosomal cassette containing the *mec* gene that confers methicillin resistance. The combination of elements found within the SCC*mec* cassette confer a SCC*mec* type that can help determine the origin and spread of MRSA.

MRSA clone nomenclature: The Gram-positive Typing Laboratory uses universally standardised MRSA nomenclature allowing MRSA clones to be readily compared between laboratories. The MLST sequence type and the SCC*mec* type are combined. For example, an MRSA clone of ST22 and SCC*mec* type IV [2B] is referred to as ST22-IV [2B]. Colloquial names, in common usage in WA, are also used in this report.

5 Introduction

In Western Australia (WA) methicillin-resistant *Staphylococcus aureus* (MRSA) is a notifiable organism and as per the Western Australian Department of Health operational directive (*OP0478/13 Infection Prevention and Control of Methicillin-resistant Staphylococcus aureus [MRSA] in Western Australian Healthcare Facilities: http://www.health.wa.gov.au/circularsnew/circular.cfm?Circ_ID=13040*) medical microbiology laboratories are required to refer all non-environmental isolates to the PathWest Gram-positive Typing Laboratory at Fiona Stanley Hospital for characterisation.

The MRSA isolate is determined to be either a micro-alert B or C clone based on a number of criteria. The clone type is reported for PVL-positive and/or micro-alert C MRSA. Non-micro-alert C PVL-negative MRSA are reported as “Micro-alert B, PVL-negative MRSA”.

Micro-alert C clones are determined by the WA Multi-Resistant Organism Expert Advisory Group and include:

- All healthcare-associated MRSA (HA-MRSA)
- Community-associated MRSA (CA-MRSA) with increased virulence or transmissibility of antimicrobial resistance. Currently three PVL-positive CA-MRSA clones are characterised as micro-alert C:
    - USA300 (ST8-IV [2B])
    - Bengal Bay MRSA (ST772-V [5C2])
    - ST22-IV [2B]

Based on the clone type and type of micro-alert assigned (i.e. micro-alert B or C) and on the specific setting, a risk assessment is made by the healthcare facility in the management of MRSA-positive patients.

6 Methods

MRSA are characterised by phenotypic and genotypic methods. Phenotyping includes antibiogram (as provided by the referring laboratory) and urease detection. If required, susceptibility testing is performed by disc diffusion (CLSI) to gentamicin, erythromycin, tetracycline, ciprofloxacin, trimethoprim, fusidic acid and rifampicin.

The genotyping methods selectively employed are:

- Polymerase chain reaction (PCR) targeting *mecA*, *nuc*, PVL and *aroE*
- Restriction enzyme assays:
    - Pulsed-field gel electrophoresis
    - Restriction fragment length polymorphisms of the *coa* gene
- DNA microarray
- Whole genome sequencing

7 MRSA Isolated in Western Australia, July 2022 to June 2023

From July 1 2022 to June 30 2023, 8,473 non-duplicate MRSA were referred to the PathWest Gram-positive Typing Laboratory; a 6.4% increase on the 7,967 referred in 2021/2022. A duplicate isolate was defined as an isolate with an identical phenotype to an isolate received from the same patient within the previous 12 months.

Table 1: Unique isolates of MRSA in Western Australia, July 2022 to June 2023

	Patient Isolates n = 8,399 (99.1%)		HCW isolates n = 74 (0.9%)		
MRSA	**Clinical**	**Screen**	**Clinical**	**Screen**	**n (%)**
Micro-alert C, PVL Negative	438	130	0	5	573 (6.8)
Micro-alert C, PVL Positive	266	33	0	3	302 (3.5)
Micro-alert B, PVL Negative	2982	606	0	55	3,643 (43)
Micro-alert B, PVL Positive	3817	127	1	10	3,955 (47)
TOTAL	**7,503**	**896**	**1**	**73**	**8,473**

PVL: Panton-Valentine leucocidin; HCW: Healthcare worker

7.1 Micro-alert C MRSA

Of the 8,473 unique isolates referred to the PathWest Gram-positive Typing Laboratory in 2022/2023, 875 (10%) were identified as micro-alert C MRSA (Table 2).

Table 2: Micro-alert C MRSA in Western Australia, July 2022 to June 2023

MLST-SCC*mec*	Clone	Patient Isolates 867 (99.1%)		HCW isolates 8 (0.9%)		Total
		Clinical	**Screen**	**Clinical**	**Screen**	
HA-MRSA						
ST22-IV [2B]	UK 15/ EMRSA-15	433	124	0	5	562
ST5-II [2A]	New York Japan MRSA/USA100	0	2	0	0	2
ST239-III [3A]	Aus-2/3 EMRSA	4	1	0	0	5
ST36-II [2A]	UK 16/ EMRSA-16	1	1	0	0	2
ST225-MRSA- II [2A]		0	2	0	0	2
Total HA-MRSA		**438**	**130**	**0**	**5**	**573**
CA-MRSA						
ST22-IV [2B]	PVL-positive ST22	156	25	0	3	184
ST8-IV [2B]	USA300	95	7	0	0	102
ST772-V [5C2]	Bengal Bay MRSA	15	1	0	0	16
Total CA-MRSA		**266**	**33**	**0**	**3**	**302**
Total Micro-alert C MRSA		**704**	**163**	**0**	**8**	**875**

HA-MRSA: Healthcare-associated MRSA; CA-MRSA: community-associated MRSA

The average age of patients with a micro-alert C MRSA was 62 years (median 71 years). Patients with a PVL-positive micro-alert C MRSA were significantly younger (37 years [median 33 years]) than patients with a PVL-negative micro-alert C MRSA (75 years [median 81 years], P <0.01). The higher average age for the PVL-negative micro-alert C MRSA patient is a reflection of the dominance of the healthcare associated UK 15 clone which has become endemic in Western Australian aged care facilities (15).

7.2 Micro-alert B MRSA

Of the 8,473 unique isolates referred to the PathWest Gram-positive Typing Laboratory in 2022/2023, 7,598 (86%) were identified as micro-alert B MRSA (Table 3).

Table 3: Micro-alert B MRSA in Western Australia, July 2022 to June 2023

MLST-SCC*mec*	Clone	Patient Isolates 7,532 (99.1%)		HCW isolates 66 (0.9%)		Total
		Clinical	Screen	Clinical	Screen	
Panton-Valentine leucocidin Negative CA-MRSA						
Total PVL Negative		**2,982**	**606**	**0**	**55**	**3,643**
Panton-Valentine leucocidin Positive CA-MRSA						
ST93-IV [2B]	Queensland	2,233	57	0	5	2,295
ST5-IV [2B]	WA 121	1,100	44	0	0	1,144
ST30-IV [2B]	WSPP[a]	245	10	0	1	256
ST1232-V [5C2]		69	2	0	0	71
ST59/952-IV/V [2B/5C2&5]	Taiwan Group	42	4	0	0	46
ST5-IV [2B]	WA 3	23	4	1	2	30
ST78-IV [2B]	WA 2	18	2	0	0	20
ST1633-V [5C2]	WA 89	16	1	0	1	18
ST30-V [5C2]	WA 124	12	0	0	0	12
ST88-V [5C2]	WA 117	11	0	0	0	11
ST923-IV [2B]	WA 62	10	1	0	0	11
ST6-IV [2B]	WA 51	9	1	0	1	11
ST1-IV [2B]	WA 1	7	0	0	0	7
ST80-IV [2B]	European Clone	6	0	0	0	6
ST1420-MRSA-IV [2B]	WA 126	4	0	0	0	4
ST30-novel	ST30-Novel	3	0	0	0	3
ST573-V [5C2]	WA 10	1	1	0	0	2
ST1153-V [5C2]	ST1153-Novel	2	0	0	0	2
ST1-V [5C2&5]	WA 137	2	0	0	0	2
ST5-IV [2B]	Sri Lankan Clone variant	1	0	0	0	1
ST789-V [5C2]	WA 131	1	0	0	0	1
ST1005-IV [2B]	WA 57	1	0	0	0	1

MLST-SCC*mec*	Clone	Patient Isolates 7,532 (99.1%)		HCW isolates 66 (0.9%)		Total
		Clinical	Screen	Clinical	Screen	
ST2974-V [5C2]	WA 129	1	0	0	0	1
Total PVL Positive		**3,817**	**127**	**1**	**10**	**3,955**
Total Micro-alert B MRSA		**6,799**	**733**	**1**	**65**	**7,598**

[a]WSPP: Western Samoan Phage Pattern, also known as the South Western Pacific (SWP) clone or Oceanic clone.

The average age of patients with a micro-alert B MRSA was 41 years (median 37 years). Patients with a PVL-positive micro-alert B MRSA were significantly younger (30 years [median 28 years]) than patients with a PVL-negative micro-alert B MRSA (53 years [median 55 years], P<0.01).

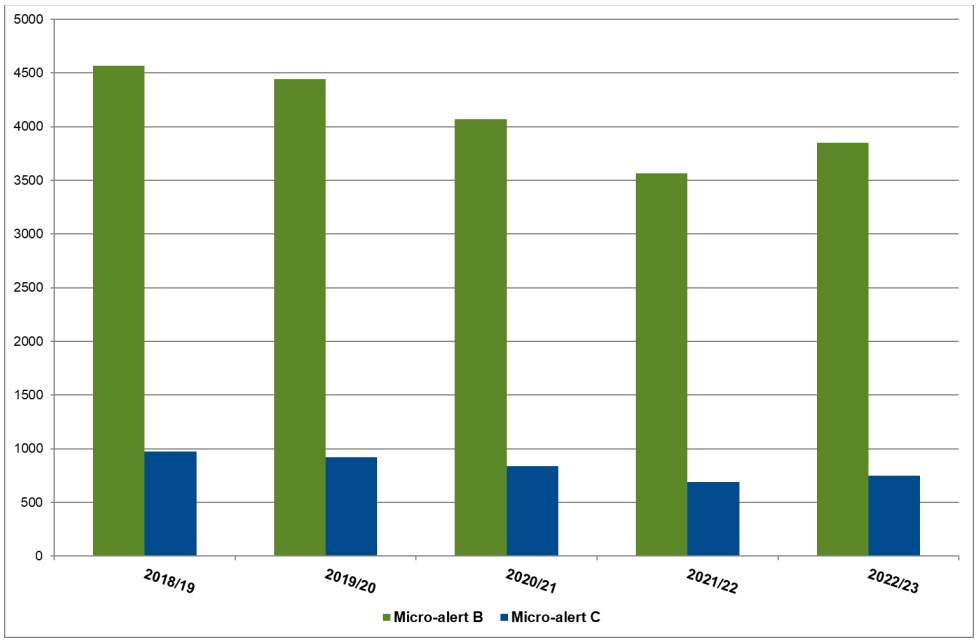
A significant difference in the mean ages of micro-alert C (62 years) and micro-alert B (41 years) patients was also identified (P<0.01). This was primarily due to the predominance of UK 15 in micro-alert C patients and PVL–positive CA-MRSA in micro-alert B patients.

7.3 Micro-alert C versus Micro-alert B MRSA Clones

In 2022/2023, 875 (10%) MRSA were micro-alert C and 7,598 (90%) were micro-alert B.

Over the past five years, micro-alert C MRSA declined significantly (P<0.01) predominantly due to the decline in UK 15 (P<0.01) from 8.4% (814/9,736) to 6.6% of MRSA (562/8,473). The only micro-alert C clone to increase significantly (P<0.01) was PVL-positive ST22-IV [2B] from 1.5% (149/9,736) to 2.2% (184/8,473). Several clones, common in WA in the early 2000s (e.g. Aus 2/3 EMRSA ST239-III [3A], NY/Japan and UK 16) are now rarely seen in WA.

Figure 1: Annual number of referred isolates of MRSA in Western Australia, 2018/2019 to 2022/2023



7.4 Panton-Valentine Leucocidin Positive Clones

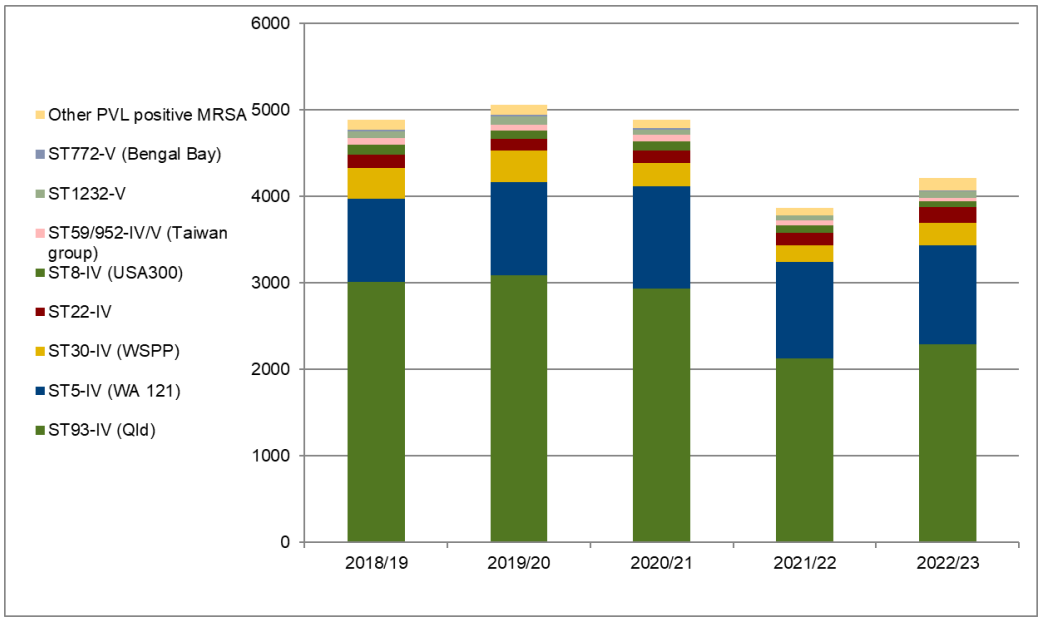
CA-MRSA harbouring the Panton-Valentine Leucocidin (PVL)-associated genes emerged in WA in the early 2000s.

In 2022/2023, 50% of all MRSA in WA harboured the genetic determinants for PVL. The most successful PVL-positive clone is known colloquially as the Queensland (Qld) clone. First described in the early 2000s in Queensland (16), the Qld clone has become the dominant PVL-positive CA-MRSA clone in WA (Figure 2). WA 121, which was initially identified in 2010 in the Kimberley region, is also a predominant PVL-positive CA-MRSA clone in WA. WA 121 is thought to have been introduced into Australia based on the SCC*mec* IV subtype. WA 121 has a SCC*mec* IVo whereas SCC*mec* IVa is attributed to Australian origin (14).

In addition, several international PVL-positive CA-MRSA were identified including: WSPP, PVL-positive ST22-IV [2B], USA300, Bengal Bay MRSA, the Taiwan Group, ST1232-V [5C2], European MRSA and Sri Lankan Clone variant.

PVL-positive ST22-IV [2B], USA300 and Bengal Bay MRSA have been reported to cause single strain hospital outbreaks (17; 18; 19) and therefore have been classified as micro-alert C MRSA.

Figure 2: Annual number of referred isolates of PVL-positive MRSA in Western Australia, 2018/2019 to 2022/2023



As PVL-positive MRSA are known to cause severe skin and soft tissue infections that often require hospitalisation in young otherwise healthy people, the high proportion of MRSA isolated in WA identified as PVL positive is a public health concern. Of particular concern has been the rapid emergence of PVL-positive MRSA in the state's north-west, particularly amongst the Aboriginal populations. In 2022/2023 in the Kimberley, Pilbara, Midwest and Goldfields health regions, the Qld clone was identified in 1,045.6, 500.5, 346.9 and 210.7 per 100,000 population respectively and WA 121 was identified in 1,243.4, 207, 140.2 and 138.7 per 100,000 population respectively (Table 5).

Figure 3: Annual percentage of referred MRSA identified as PVL-positive MRSA in Western Australia, 2018/2019 to 2022/2023

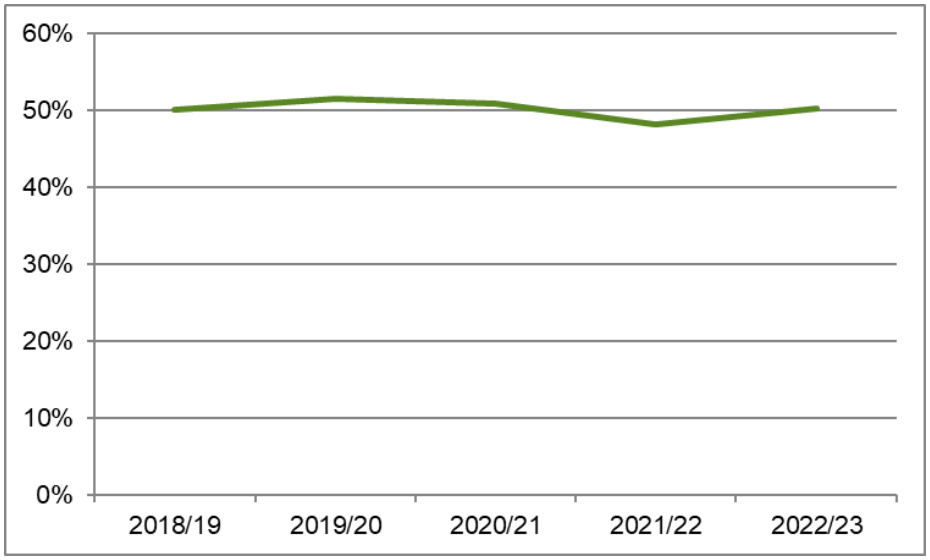


Table 4: New MRSA cases notified to Department of Health by Health Region according to postcode of residence, July 2022 to June 2023

		Health Region									
MLST/SCC*mec*	**Common name, PVL status**	**Kimb**	**Pilb**	**Midw**	**Gold**	**Wheat**	**Metro**	**SthW**	**GSth**	**Not WA**	**Total**
Micro-alert C Clones											
ST22-IV [2B]	UK 15, (UK EMRSA-15), PVL negative		1	2	7	19	492	33	6	2	562
ST22-IV [2B]	ST22-IV, PVL positive	1	4	2	2	3	152	6	3	11	184
ST8-IV [2B]	USA300, PVL positive		1	1	4	2	79	8	2	5	102
ST772-V [5C2]	Bengal Bay Clone, PVL positive						16				16
ST239-III [3A]	Aus-2/3 EMRSA and var., PVL negative						5				5
ST5-II [2A]	New York/Japan MRSA, PVL negative						1	1			2
ST36-II [2A]	UK 16 (EMRSA-16), PVL negative				1		1				2
ST225-II [2A]							1		1		2
Total Micro-alert C Clones		1	6	5	14	24	747	48	12	18	875
Micro-alert B Clones											
ST93-IV [2B]	Qld clone, PVL positive	407	295	235	120	68	940	105	71	54	2,295
ST5-IV [2B]	WA MRSA-121, PVL positive	484	122	95	79	18	283	29	10	24	1,144
ST30-IV [2B]	WSPP MRSA, PVL positive	9	15	15	9	5	178	12	1	12	256
ST1232-V [5C2]	ST1232-V, PVL positive	1		2		2	56	4	1	5	71
ST59/952- IV/V [2B/5C2&5]	Taiwan Group (includes Taiwan Clone, Taiwan A, WA 55 and WA 56)					1	38	1	4	2	46
Other Micro-alert B, PVL positive Clones		1	2	1	1	2	101	13	3	19	143
Micro-alert B, PVL negative MRSA		378	230	190	190	88	2,252	200	65	50	3,643
Total Micro-alert B Clones		1,280	664	538	399	184	3,848	364	155	166	7,598
Total MRSA		1,281	670	543	413	208	4,595	412	167	184	8,473

Kimb = Kimberley, Pilb = Pilbara, Midw = Midwest, Gold = Goldfields, Wheat = Wheatbelt, Metro = Metropolitan Perth, SthW = South West, GSth = Great Southern, Not WA = Outside WA.

Table 5: MRSA notification rates per 100,000 population by Health Region according to postcode of residence, July 2022 to June 2023

		Health Region								
MLST/SCC*mec*	**Common name, PVL status**	**Kimb**	**Pilb**	**Midw**	**Gold**	**Wheat**	**Metro**	**SthW**	**GSth**	**WA**
Micro-alert C Clones										
ST22-IV [2B]	UK 15 (EMRSA-15), PVL negative		1.7	3.0	12.3	24.3	22.1	16.7	9.3	20.1
ST22-IV [2B]	ST22-IV, PVL positive	2.6	6.8	3.0	3.5	3.8	6.8	3.0	4.7	6.2
ST8-IV [2B]	USA300, PVL positive	2.6	6.8	1.5	7.0	2.6	3.5	4.0	3.1	3.5
ST772-V [5C2]	Bengal Bay Clone, PVL positive						0.7			0.6
ST239-III [3A]	Aus-2/3 EMRSA, PVL negative						0.2			0.2
ST5-II [2A]	New York/Japan MRSA, PVL negative						0.04	0.5		0.1
ST36-II [2A]	UK 16 (EMRSA-16), PVL negative				1.8		0.04			0.1
ST225-II [2A]							0.04		1.6	0.1
Total Micro-alert C Clones		2.6	10.2	7.4	24.6	30.6	33.6	24.2	18.6	31.4
Micro-alert B Clones										
ST93-IV [2B]	Qld clone, PVL positive	1045.6	500.5	346.9	210.7	86.8	42.2	53.0	110.2	82.3
ST5-IV [2B]	WA MRSA-121, PVL positive	1243.4	207.0	140.2	138.7	23.0	12.7	14.6	15.5	41.0
ST30-IV [2B]	WSPP MRSA, PVL positive	23.1	25.4	22.1	15.8	6.4	8.0	6.1	1.6	8.7
ST1232-V [5C2]	ST1232-V, PVL positive	2.6		3.0		2.6	2.5	2.0	1.6	2.4
ST59/952- IV/V [2B/5C2&5]	Taiwan Group (includes Taiwan Clone, Taiwan A, WA 55 and WA 56)					1.3	1.7	0.5	6.2	1.6
Other Micro-alert B, PVL positive Clones		2.6	3.4	1.5	1.8	2.6	4.5	6.6	4.7	4.4
Micro-alert B, PVL negative MRSA		971.1	390.2	280.5	333.6	112.4	101.2	100.9	100.9	130.6
Total Micro-alert B Clones		3288.4	1126.6	794.1	700.5	234.9	172.9	183.7	240.7	272.4
Total MRSA		3290.9	1136.7	801.5	725.1	265.6	206.5	207.9	259.3	303.8

Kimb = Kimberley, Pilb = Pilbara, Midw = Midwest, Gold = Goldfields, Wheat = Wheatbelt, Metro = Metropolitan Perth, SthW = South West, GSth = Great Southern. Regional population figures (2021 - 2022) obtained from the Australian Bureau of Statistics

8 Significant Micro-alert C Clones

8.1 UK 15 (EMRSA-15, ST22-IV [2B]) – PVL NEGATIVE

UK 15 (colloquially known as EMRSA-15) is a global healthcare-associated clone frequently isolated from aged care residents (20). Initially introduced into WA in 1997 by overseas healthcare workers, UK 15 has become the dominant Micro-alert C MRSA clone in WA (n=562 in 2022/2023) accounting for 6.6% of all MRSA and 64% of micro-alert C MRSA.

***Phenotypic Features**:* UK 15 is urease negative and typically ciprofloxacin resistant. Approximately 29% of isolates were also erythromycin resistant. In recent years a ciprofloxacin susceptible, trimethoprim resistant variant of ST22-IV [2B] has emerged. In 2022/2023, 23 ST22-IV [2B] (4.1%) demonstrated this phenotype.

***Western Australian Notification Rate*:** 20.1 per 100,000 (Table 5).

Geographic Distribution: Although isolated in all health regions, 88% of isolates were from patients/healthcare workers residing in the Perth metropolitan region (Table 4).

Patient Age: The mean age of patients infected/colonised with UK 15 was 76 years (median 82 years); a reflection of the frequent isolation of this clone from patients residing in aged care facilities.

Figure 4: Annual number of referred isolates of UK 15 (ST22-IV [2B]) in Western Australia, 2018/2019 to 2022/2023

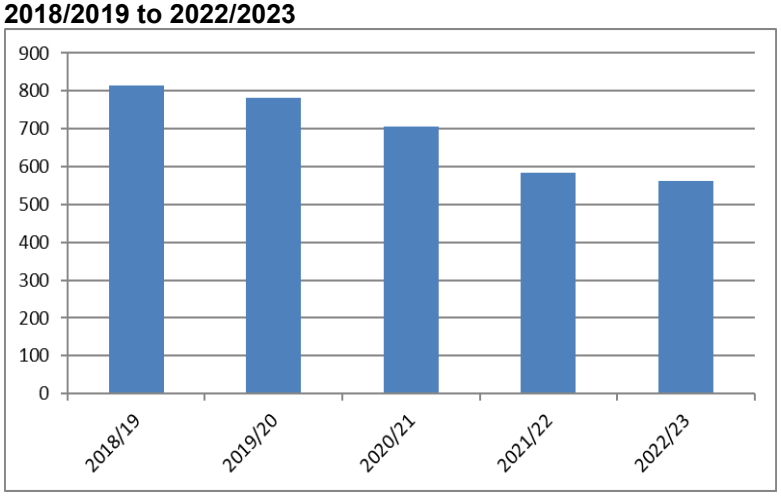
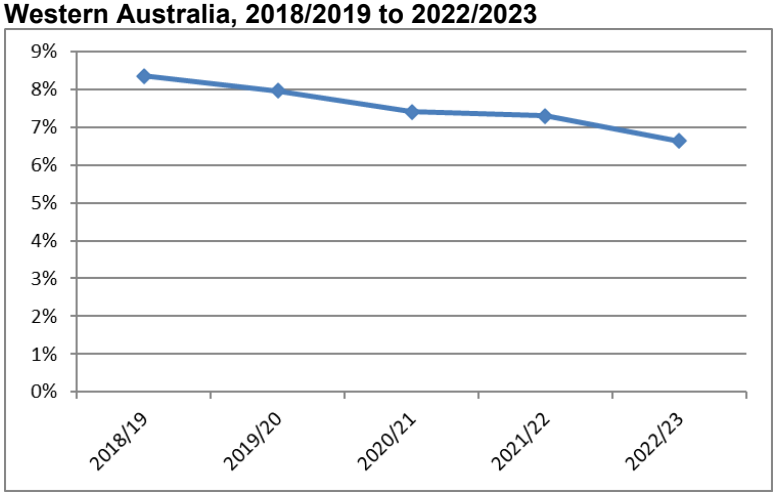


Figure 5: UK 15 (ST22-IV [2B]) as a percentage of the annual number of referred MRSA in Western Australia, 2018/2019 to 2022/2023



8.2 ST22-IV [2B] – PVL POSITIVE

PVL-positive ST22-IV [2B] is genetically distinct from PVL-negative UK 15 and is considered community-associated. Despite this, hospital outbreaks have been reported overseas and in Australia (21; 22) resulting in a micro-alert C classification. In 2022/2023 PVL-positive ST22-IV [2B] (n=184) accounted for 2.2% of all MRSA and 21% of micro-alert C MRSA.

***Phenotypic Features**:* PVL-positive ST22-IV [2B] is urease negative, and is typically ciprofloxacin resistant with a gentamicin MIC >=4 mg/L.

***Western Australian Notification Rate*:** 6.2 per 100,000 (Table 5)

***Geographic Distribution*:** In 2022/2023 although predominantly isolated in the Perth Metropolitan health region (88%) a small number of isolates were identified in the Pilbara, Goldfields, Midwest, South West, Wheatbelt and Great Southern regions. (Table 4).

Patient Age: The mean age of patients infected/colonised with PVL-positive ST22-IV [2B] was 34 years (median 32 years). Unlike PVL-negative UK 15, PVL-positive ST22-IV [2B] has not become established in aged care facilities.

Figure 6: Annual number of referred isolates of PVL-positive ST22-IV [2B] in Western Australia, 2018/2019 to 2022/2023

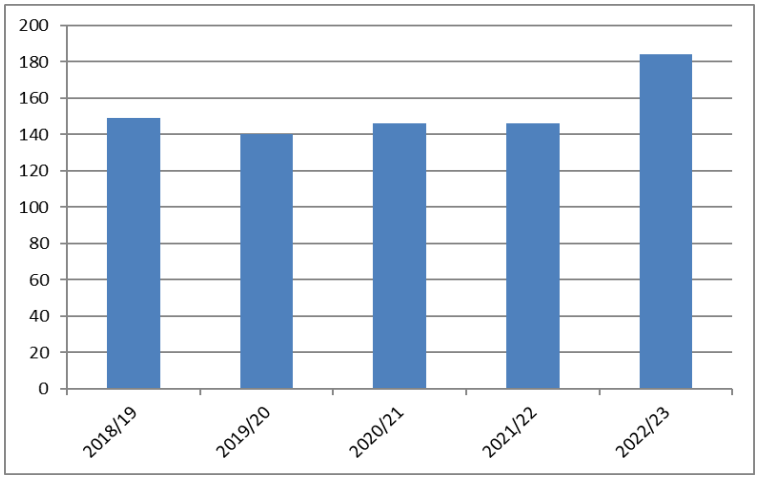
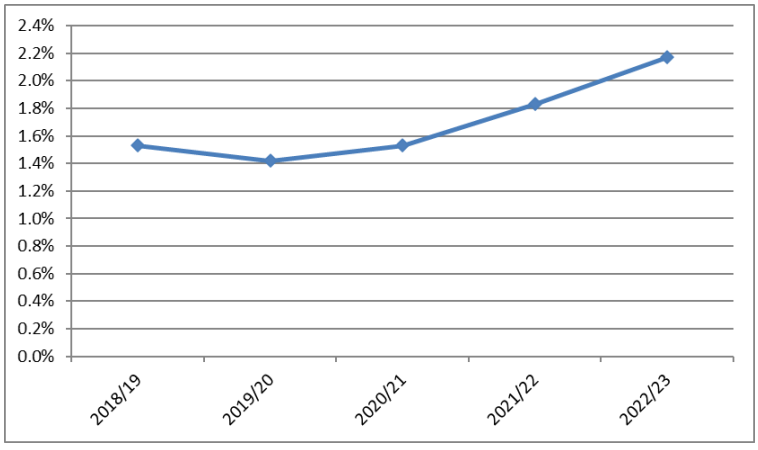


Figure 7: PVL-positive ST22-IV [2B] as a percentage of the annual number of referred MRSA in Western Australia, 2018/2019 to 2022/2023



8.3 USA300 (ST8-IV [2B])

PVL-positive USA300 expanded in the USA in the early 2000s and by 2011 was the most frequently isolated MRSA isolated in the USA (23). USA300 was first reported in WA in 2003 (6) but has not become established in the state. In 2022/2023, PVL-positive USA300 (n=102) accounted for 1.2% of all MRSA and 12% of micro-alert C MRSA.

Phenotypic Features: USA300 is urease positive. The USA300 antibiogram is variable with 57% of isolates susceptible to the non-β-lactams tested, and 26% resistant to at least two non-β-lactam antimicrobials.

Western Australian Notification Rate: 3.5 per 100,000 (Table 5).

Geographic Distribution: In 2022/2023 the majority (77%) of USA300 was identified in the Perth Metropolitan health region with a small number identified in the South West, Wheatbelt, Pilbara, Goldfields, Midwest, South West and Great Southern regions (Table 4).

Patient Age: The mean age of patients infected/colonised with USA300 was 42 years (median 42 years).

Figure 8: Annual number of referred isolates of USA300 (ST8-IV [2B]) in Western Australia, 2018/2019 to 2022/2023

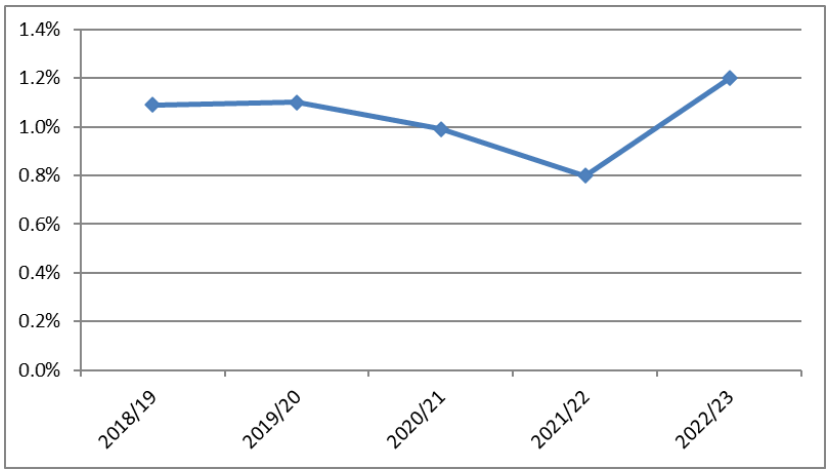
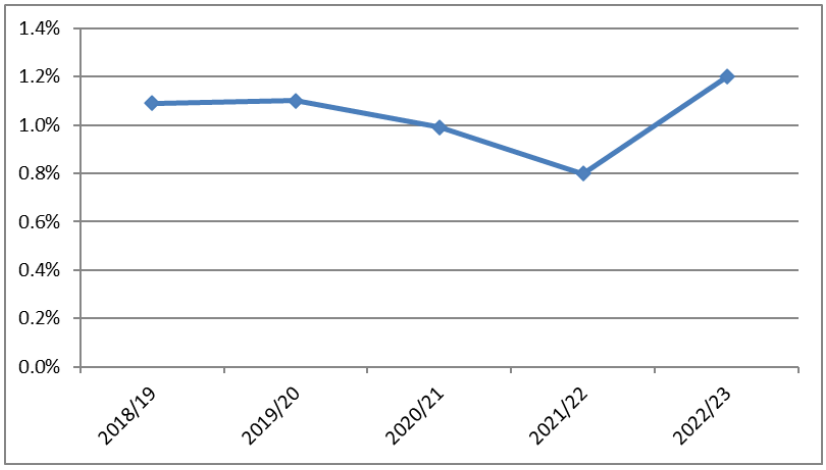


Figure 9: USA300 (ST8-IV [2B]) as a percentage of the annual number of referred MRSA in Western Australia, 2018/2019 to 2022/2023



8.4 Bengal Bay MRSA (ST772-V [5C2])

Bengal Bay MRSA is a community-associated, multidrug-resistant PVL-positive MRSA first reported in Bangladesh, and subsequently in India, Malaysia and several European countries (24; 25; 26; 27; 28). Short-term outbreaks in community and health care settings have been reported. Bengal Bay MRSA was first identified in WA in 2007 but has not become established in the state. In 2022/2023 Bengal Bay MRSA (n=16) accounted for 0.2% of all MRSA and 1.8% of micro-alert C MRSA.

Phenotypic Features: Bengal Bay MRSA is urease positive and typically erythromycin, trimethoprim, gentamicin and ciprofloxacin resistant. In 2022/2023, seven of Bengal Bay MRSA were susceptible to gentamicin.

Western Australian Notification Rate: 0.6 per 100,000 (Table 5).

Geographic Distribution: In 2022/2023 Bengal Bay MRSA was isolated in the Perth Metropolitan region only (Table 4).

Patient Age: The mean age of patients infected/colonised with Bengal Bay MRSA was 34 years (median 34 years).

Figure 10: Annual number of referred isolates of Bengal Bay MRSA (ST772-V [5C2]) in Western Australia, 2018/2019 to 2022/2023

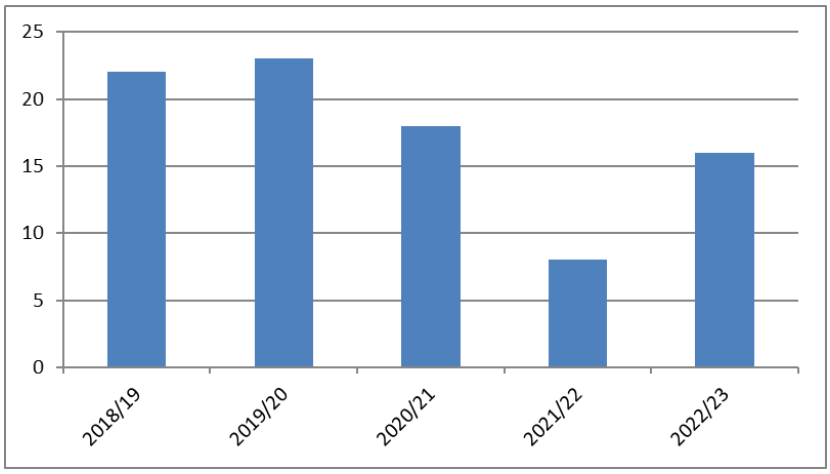
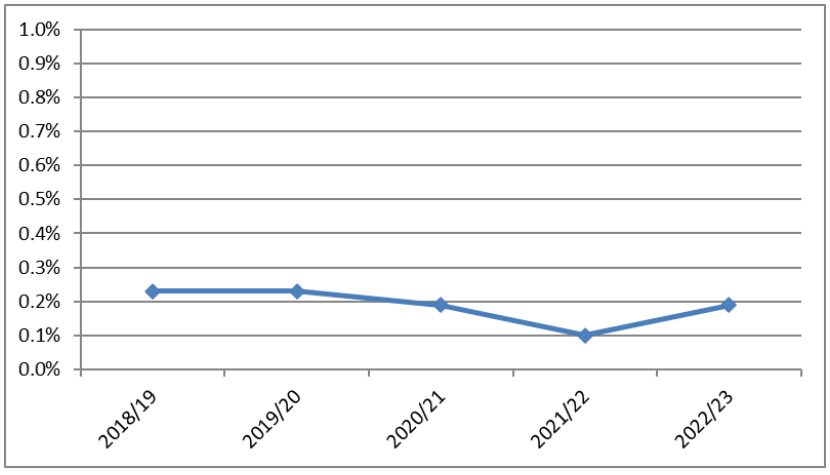


Figure 11: Bengal Bay MRSA (ST772-V [5C2]) as a percentage of the annual number of referred MRSA in Western Australia, 2018/2019 to 2022/2023



8.5 New York/Japan MRSA (ST5/764-II [2A])

New York/Japan MRSA (also known as USA100) is a healthcare-associated MRSA clone frequently isolated in Japan and the USA (29). A single strain outbreak of New York/Japan MRSA was identified in the South West region of WA in 2005 (1). The index case was a colonised healthcare worker who had previously been hospitalised in New York. By having a state-wide MRSA policy, the outbreak was able to be managed and controlled by the Western Australian Health Department. Since then, the number of New York/Japan MRSA has remained low (fewer than 20 per year). In 2022/2023 New York/Japan MRSA (n=4) accounted for 0.02% of all MRSA and 0.2% of micro-alert C MRSA.

Phenotypic Features: New York/Japan MRSA is urease positive and typically ciprofloxacin and erythromycin resistant.

Western Australian Notification Rate: 0.1 per 100,000 (Table 5).

Geographic Distribution: In 2022/2023 New York/Japan MRSA was identified in the Perth metropolitan and the South West region (Table 4).

Patient Age: The mean age of patients infected/colonised with New York/Japan MRSA was 79 years (median 79 years).

Figure 12: Annual number of referred isolates of New York/Japan MRSA (ST5-II [2A]) and variants in Western Australia, 2018/2019 to 2022/2023

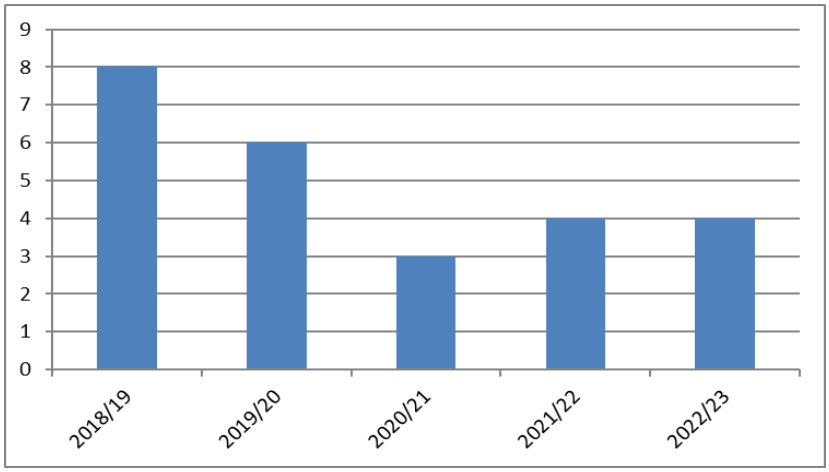
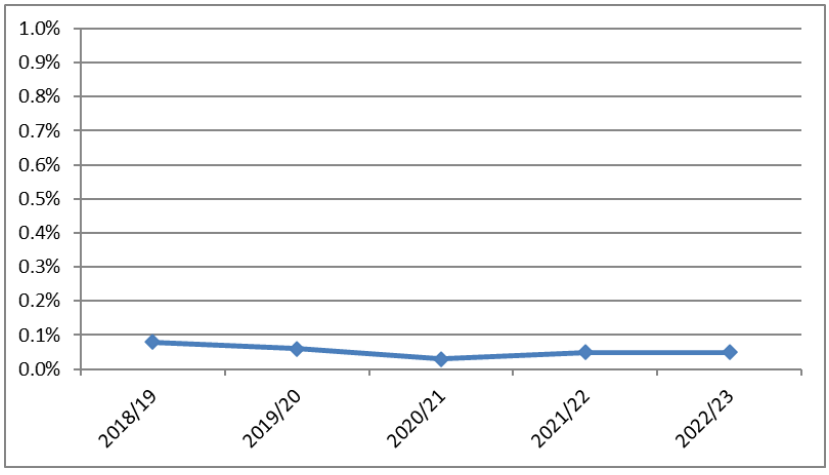


Figure 13: New York/Japan MRSA (ST5-II [2A]) and variants as a percentage of the annual number of referred MRSA in Western Australia, 2018/2019 to 2022/2023



8.6 UK 16 (EMRSA-16, ST36-II [2A])

UK 16 (colloquially known as EMRSA-16) was a predominant MRSA clone in the United Kingdom healthcare setting (30). In recent years UK 16 has become increasingly rare in the UK (31). UK 16 caused an outbreak in 2002 – 2003 in a Perth metropolitan hospital – the index case was a colonised health care worker from Scotland. Since this time only small numbers of isolates have been detected. In 2022/2023 UK 16 (n=2) accounted for 0.02% of all MRSA and 0.2% of micro-alert C MRSA.

Phenotypic Features: UK16 is urease positive and typically ciprofloxacin and erythromycin resistant.

Western Australian Notification Rate: 0.1 per 100,000 (Table 5).

Geographic Distribution: In 2022/2023, UK 16 was identified in the Perth metropolitan and the Goldfields health region (Table 4).

Patient Age: The mean age of patients infected/colonised with UK 16 was 75 years (median 78 years).

Figure 14: Annual number of referred isolates of UK 16 (ST36-II [2A]) in Western Australia, 2018/2019 to 2022/2023

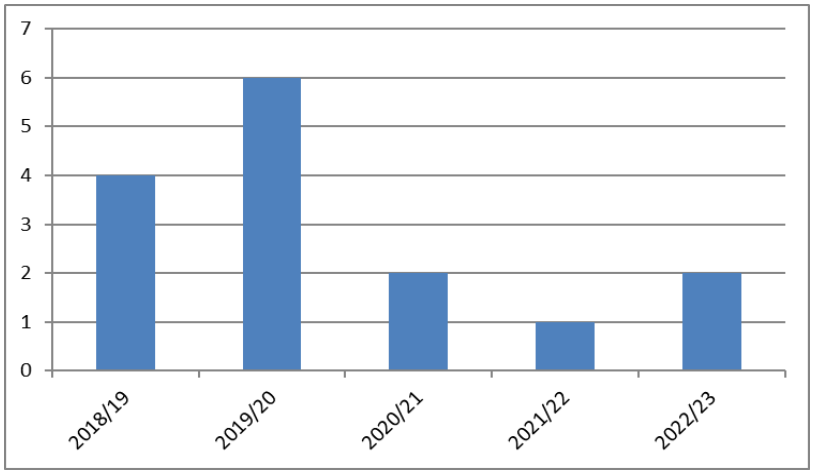
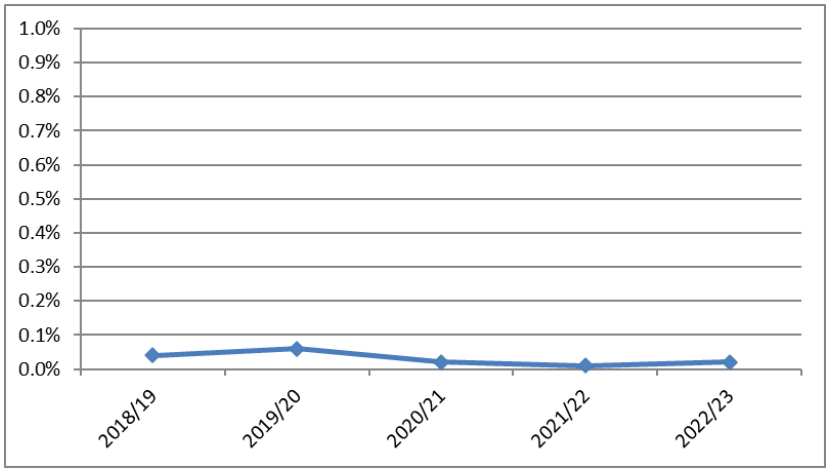


Figure 15: UK 16 (ST36-II [2A]) as a percentage of the annual number of referred MRSA in Western Australia, 2018/2019 to 2022/2023



8.7 Aus-2/3 EMRSA (ST239-III [3A])

Prior to the emergence of UK 15, Aus-2/3 EMRSA was the dominant healthcare associated MRSA clone in Australia (32). Unlike other Australian states, Aus-2/3 EMRSA did not become established in Western Australian hospitals. This is likely due to the screening and segregation of patients who had been hospitalised in the Eastern States (the "search and destroy" policy implemented by the Western Australian Health Department in 1982). In 2022/2023 Aus-2/3 EMRSA (n=5) accounted for 0.06% of all MRSA and 0.6% of micro-alert C MRSA.

***Phenotypic Features**:* Aus-2/3 EMRSA is urease positive and multiresistant.

***Western Australian Notification Rate*:** 0.2 per 100,000 (Table 5).

***Geographic Distribution*:** In 2022/2023 Aus-2/3 EMRSA was identified in the Perth metropolitan region (Table 4).

Patient Age: The mean age of patients infected/colonised with Aus-2/3 EMRSA was 50 years (median 57 years).

Figure 16: Annual number of referred isolates of Aus-2/3 EMRSA (ST239-III [3A]) and variants in Western Australia, 2018/2019 to 2022/2023

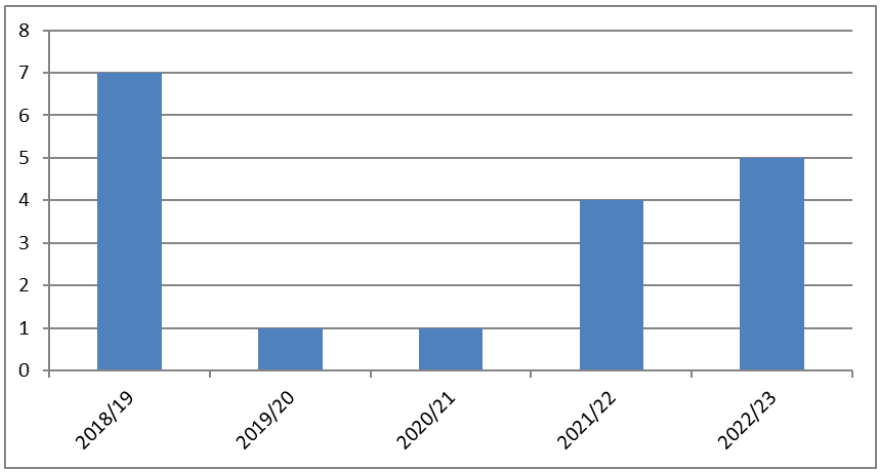
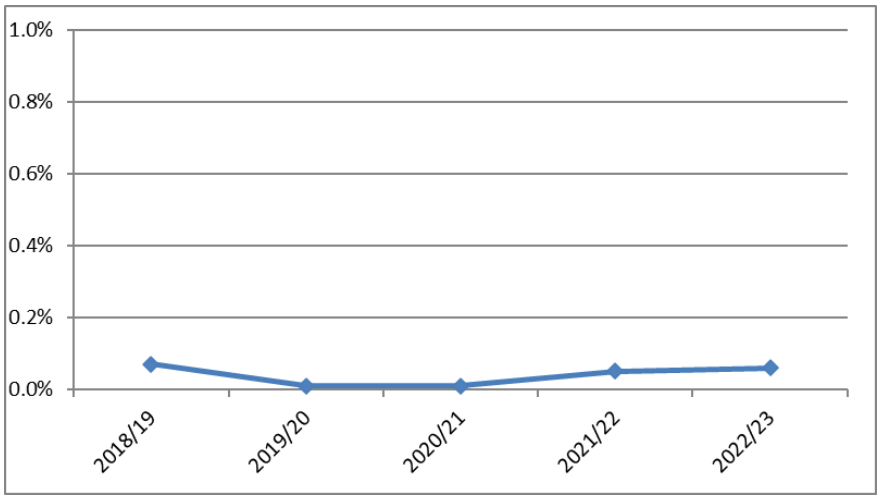


Figure 17: Aus-2/3 EMRSA (ST239-III [3A]) and variants as a percentage of the annual number of referred MRSA in Western Australia, 2018/2019 to 2022/2023



9 Significant PVL-Positive Micro-alert B Clones

9.1 Queensland Clone (ST93-IV [2B])

The Queensland (Qld) clone, initially identified in Ipswich, Queensland in the Caucasian population in 2000 (16), has become the predominant CA-MRSA in Australia (20) . In 2022/2023 the Qld clone (n=2,295) accounted for 27% of all MRSA and 30% of micro-alert B MRSA.

Phenotypic Features: The Qld clone is urease positive. Although typically susceptible to the non β-lactam antimicrobials, in 2022/2023 10% of isolates were erythromycin resistant.

Western Australian Notification Rate: 82.3 per 100,000 (Table 5).

Geographic Distribution: In 2022/2023 the Qld clone was frequently isolated in all WA health regions, with 1,045.6 per 100,000 notifications reported in the Kimberley (Table 4).

Patient Age: The mean age of patients infected/colonised with the Qld Clone was 30 years (median 28 years).

Figure 18: Annual number of referred isolates of Qld Clone (ST93-IV [2B]) in Western Australia, 2018/2019 to 2022/2023

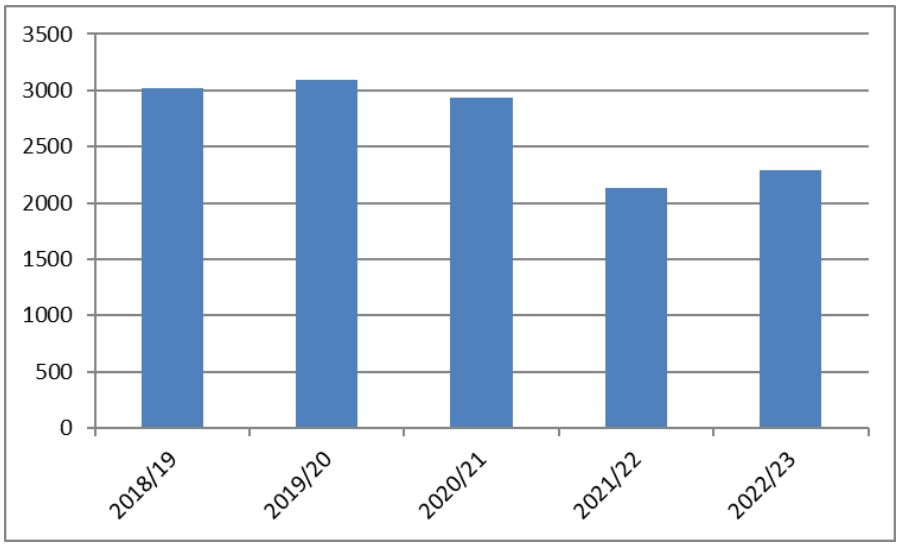
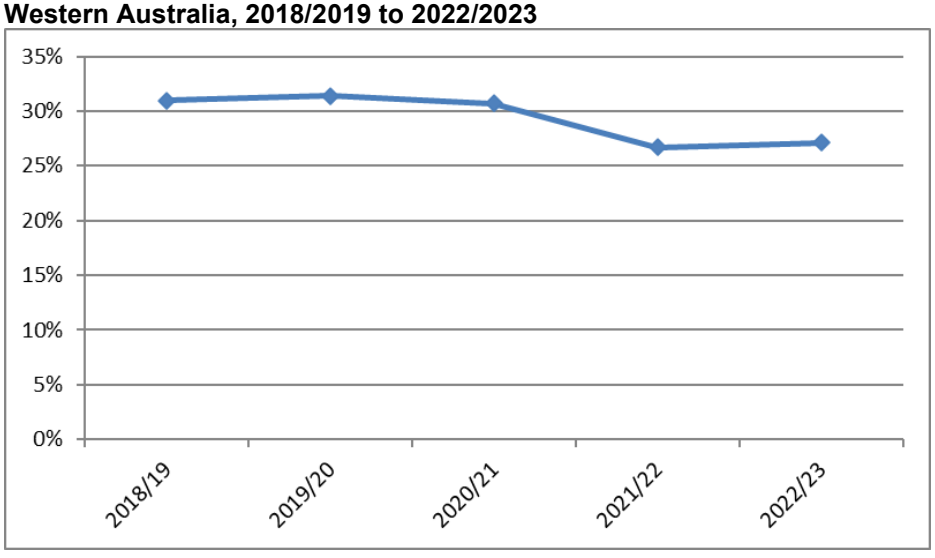


Figure 19: Qld Clone (ST93-IV [2B]) as a percentage of the annual number of referred MRSA in Western Australia, 2018/2019 to 2022/2023



9.2 ST5-IV [2B] (WA 121)

WA 121 was initially isolated in 2010 from an abdominal abscess in a 62-year-old non-Aboriginal male patient living in the Kimberley region. However, subsequently, the majority of patients with WA 121 are young Aboriginal patients living in the Kimberley and Pilbara regions. Unlike other Western Australian clonal cluster 5 MRSA clones, WA 121 carries the *edinA* epidermal cell differentiation inhibitor gene and a type IVc SCC*mec* element; a SCC*mec* subtype rarely identified in WA community-associated MRSA suggesting WA 121 was imported into WA. In 2022/2023 WA 121 (n=1,144) accounted for 14% of all MRSA and 15% of micro-alert B MRSA.

Phenotypic Features: WA121 is urease positive and trimethoprim resistant.

Western Australian Notification Rate: 41.0 per 100,000 (Table 5).

Geographic Distribution: In 2022/2023 WA 121 was frequently isolated in all WA health regions, with 1,243.4 per 100,000 notifications reported in the Kimberley (Table 4).

Patient Age: The mean age of patients infected/colonised with WA 121 was 28 years (median 25 years).

Figure 20: Annual number of referred isolates of ST5-IV [2B] (WA 121) in Western Australia, 2018/2019 to 2022/2023

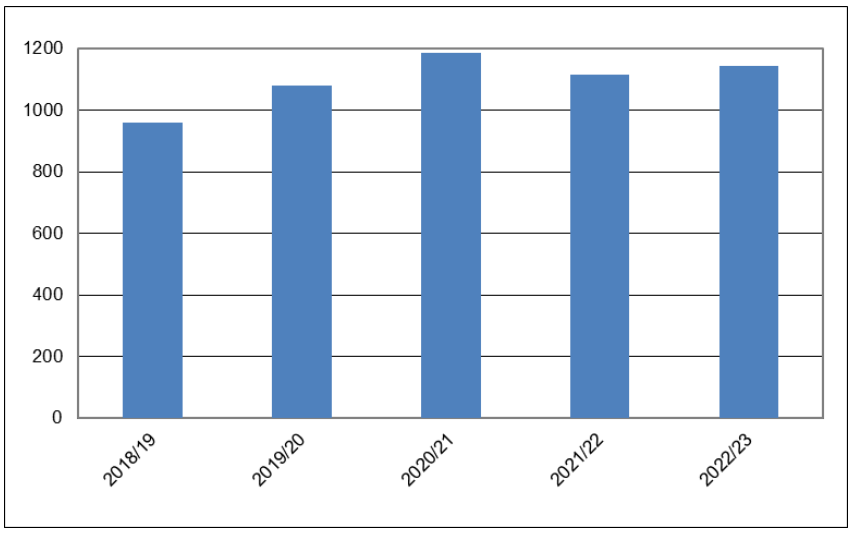
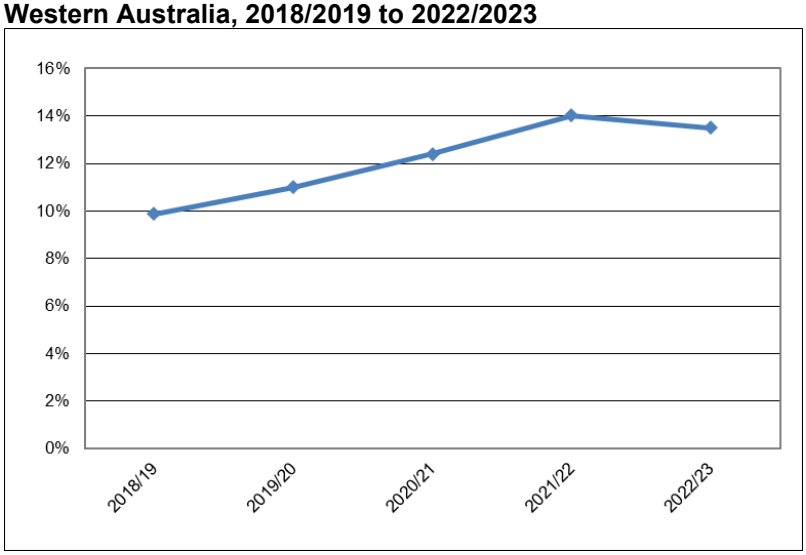


Figure 21: ST5-IV [2B] (WA 121) as a percentage of the annual number of referred MRSA in Western Australia, 2018/2019 to 2022/2023



9.3 ST30-IV [2B] (WSPP MRSA)

ST30-IV [2B], also known as the Western Samoan Phage Pattern (WSPP) MRSA, South West Pacific (SWP) or Oceania MRSA was first identified in Australia in 1997 in Polynesian patients residing on the east coast presenting with furunculosis (33). WSPP MRSA was initially isolated in WA in 2003. In 2022/2023 WSPP MRSA (n=256) accounted for 3.0% of all MRSA and 3.4% of micro-alert B MRSA.

Phenotypic Features: WSPP MRSA is urease positive and typically susceptible to the non β-lactam antimicrobials. In 2022/2023 a small proportion of isolates (7.0%) were multiresistant.

Western Australian Notification Rate: 8.7 per 100,000 (Table 5)

Geographic Distribution: In 2022/2023 WSPP was isolated in all health regions (Table 4).

Patient Age: The mean age of patients infected/colonised with WSPP was 35 years (median 33 years).

Figure 22: Annual number of referred isolates of ST30-IV [2B] (WSPP MRSA) in Western Australia, 2018/2019 to 2022/2023

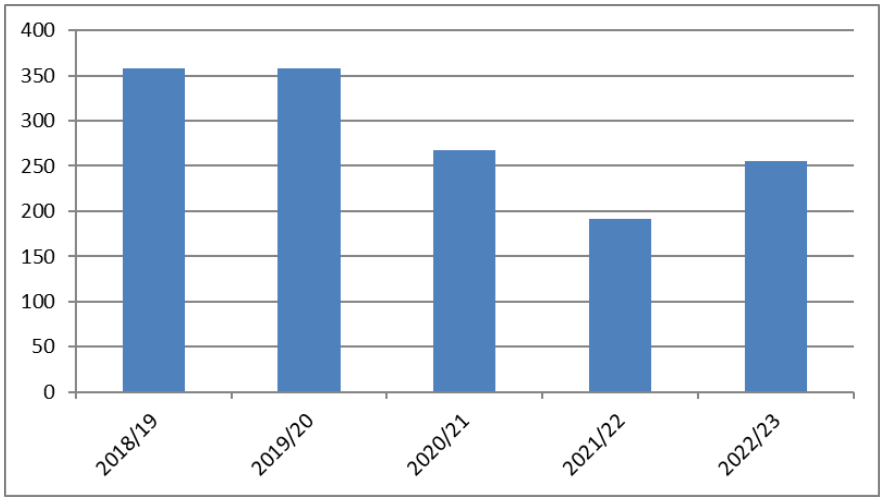
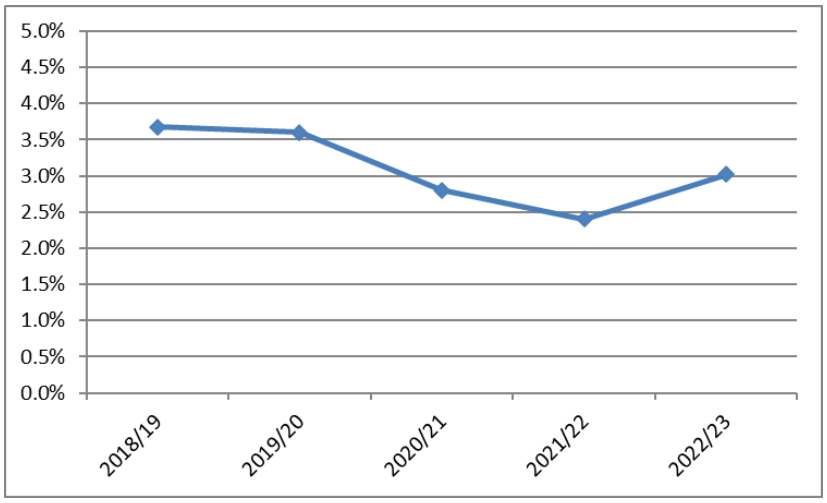


Figure 23: ST30-IV [2B] (WSPP MRSA) as a percentage of the annual number of referred MRSA in Western Australia, 2018/2019 to 2022/2023



10 Trend Data over the last five years: July 1 2018 to June 30 2023

10.1 Western Australia (Figures 24 - 26)

Micro-alert C

Over the past five years there has been a downward trend (X^2 7.7, P<0.01) in the proportion of micro-alert C isolates in WA from 11% (1,110/9,736) of MRSA in 2018/2019 to 10% (875/8,473) in 2022/2023.

The number of isolates for the following clone increased significantly over the reporting period:

- PVL positive ST22-IV [2B] from 1.5% (149/9,736) to 2.2% (184/8,473) of MRSA (X^2 15.0, P<0.01)

The number of isolates for the following clone decreased significantly over the reporting period:

- UK 15 from 8.4% (814/9,736) to 6.6% (562/8,473) of MRSA (X^2 21.6, P<0.01)

Micro-alert B

There has been an upward trend (X^2 7.7, P<0.01) in the proportion in micro-alert B isolates over the past five years from 89% (8,626/9,736) of MRSA in 2018/2019 to 90% (7,598/8,473) of MRSA in 2022/2023.

The number of isolates for the following clone increased significantly as a proportion of MRSA over the reporting period:

- WA 121 from 9.9% (961/9,736) to 14% (1,144/8,473) of MRSA (X^2 90.4, P<0.01)

The number of isolates for the following clones decreased significantly as a proportion of MRSA over the reporting period:

- The Qld clone from 31.0% (3,015/9,736) to 27.1% (2,295/8,473) of MRSA (X^2 65.3, P<0.01)
- Taiwan MRSA Group from 0.9% (87/9,736) to 0.5% (46/8,473) of MRSA (X^2 8.8, P<0.01)
- WSPP MRSA from 3.7% (358/9,9736) to 3.0% (256/8,473) of MRSA (X^2 19.6, P<0.01)

As “Micro-alert B, PVL negative MRSA” are not fully characterised it is likely the number of isolates in some uncharacterised clones within this group have increased significantly, contributing to the overall increase in micro-alert B isolates.

Changes from 2021/2022 to 2022/2023

There were no significant changes in MRSA clones in the past year.

10.2 Perth Metropolitan Health Region (Figures 27 - 29)

Micro-alert C

Over the past five years there has been a downward trend (X^2 4.4, P=0.04) in the proportion of for micro-alert C isolates in WA from 18% (972/5,537) to 16% (747/4,595) of MRSA.

The number of isolates for the following clone increased significantly over the reporting period:

- PVL positive ST22-IV [2B] from 2.3% (129/5,537) to 3.3% (152/4,595) of MRSA (X^2 12.8, P<0.01)

The number of isolates for the following clone decreased significantly over the reporting period:

- UK 15 from 13% (729/5,537) to 11% (492/4,595) of MRSA (X^2 15.6, P<0.01)

Micro-alert B

Over the past five years there has been an upward trend in the proportion of micro-alert B isolates in WA years from 82% (4,565/5,537) to 83% (3,848/4,595) (X^2 4.4, P=0.04) .

The number of isolates for following clone significantly increased as a proportion of MRSA over the reporting period:

- WA 121 from 4.9% (271/5,537) to 6.2% (283/4,595) of MRSA (X^2 10.8, P<0.01)

The number of isolates for the following clone significantly decreased as a proportion of MRSA over the reporting period:

- WSPP MRSA from 4.4% (242,5,537) to 3.9% (178/4,595) of MRSA (X^2 8.0, P<0.01)

As “Micro-alert B, PVL negative MRSA” are not fully characterised it is likely the number of isolates in some uncharacterised clones within this group have increased significantly, contributing to the overall increase in micro-alert B isolates.

Changes from 2021/2022 to 2022/2023

The number of WSPP MRSA isolates increased significantly from 2.9% (123/4253) to 3.9% (178/4595) of MRSA (P=0.01)

10.3 South West Health Region (Figures 30 - 32)

Micro-alert C

There were no significant changes in micro-alert C clones.

Micro-alert B

There were no significant changes in micro-alert B clones.

Changes from 2021/2022 to 2022/2023

There were no significant changes in MRSA clones.

10.4 Great Southern Health Region (Figures 33 - 35)

Micro-alert C

There were no significant changes in micro-alert C clones.

Micro-alert B

There were no significant changes in micro-alert B clones.

Changes from 2021/2022 to 2022/2023

The Qld clone significantly increased from 31% (63/205) to 51% (71/140) of MRSA (P<0.01)

10.5 Midwest Health Region (Figures 36 - 38)

Micro-alert C

Over the past five years there has been a downward trend (X^2 9.6, P<0.01) in the proportion of micro-alert C isolates in WA from 3.4% (20/587) to 0.9% (5/543) of MRSA.

The number of isolates for the following clone decreased significantly as a proportion of MRSA over the reporting period:

- UK 15 from 3.1% (18/587) to 0.4% (2/543) of MRSA (X^2 15.1, P<0.01).

Micro-alert B

Over the past five years there has been an upward trend (X^2 9.6, P<0.01) in the proportion of micro-alert B isolates in WA from 97% (567/587) to 99% (538/543) of MRSA

Changes from 2021/2022 to 2022/2023

WSPP increased from 0.7% (4/571) to 2.8% (15/543) of MRSA (P=0.0128)
Qld Clone increased from 37% (211/571 to 43% (235/543) of MRSA (P=0.0364)

10.6 Wheatbelt Health Region (Figures 39 - 41)

Micro-alert C

There were no significant changes in micro-alert C clones.

Micro-alert B

There were no significant changes in micro-alert B clones.

Changes from 2021/2022 to 2022/2023

There were no significant increases or decreases in MRSA clones.

10.7 Goldfields Health Region (Figures 42 - 44)

Micro-alert C

There were no significant changes in micro-alert C clones.

Micro-alert B

Over the past five years, there has been a decrease in the proportion of the Qld vlone isolates from 41% (180/441) to 29% (120/413) of MRSA (X^2 17.2, P=<0.01).

Changes from 2021/2022 to 2022/2023

The proportion of WSPP MRSA isolates increased from 0% (0/362) to 2.2% (9/413) of MRSA (P=0.01)

10.8 Pilbara Health Region (Figures 45 - 47)

Micro-alert C

Micro-alert C isolates occur infrequently: ranging between 6 and 11 isolates each year over the past five years with no significant changes.

Micro-alert B

The number of isolates for the following clones decreased significantly as a proportion of MRSA over the reporting period:

- The Qld clone from 54% (351/647) to 44% (295/670) of MRSA (X^2 14.7, P<0.01)

- WSPP MRSA from 3.9% (25/647) to 2.2% (15/670) of MRSA (X^2 11.4, P<0.01)

The number of isolates for the following clone increased significantly as a proportion of MRSA over the reporting period:

- WA 121 from 13% (81/647) to 18% (122/670) of MRSA (X^2 11.1, P<0.01)

Changes from 2020/2021 to 2021/2022

There were no significant increases or decreases in MRSA clones.

10.9 Kimberley Health Region (Figures 48 – 50)

Micro-alert C

Micro-alert C clones occur infrequently: ranging between 1 and 3 isolates each year over the past five years with no significant changes.

Micro-alert B

The number of isolates for the following clones decreased significantly as a proportion of MRSA over the reporting period:

- The Qld clone from 54% (877/1,635) to 32% (407/1,281) of MRSA (X^2 229.1, P<0.01)
- WSPP MRSA 3.0% (49/1,635) to 0.7% (9/1,281) of MRSA (X^2 13.6, P<0.01)

The number of isolates in the following clone increased significantly as a proportion of MRSA over the reporting period:

- WA 121 from 22% (351/1,635) to 38% (484/1,281) of MRSA (X^2 145.1, P<0.01).

Changes from 2021/2022 to 2022/2023

The number of isolates the WSPP MRSA clone as a proportion decreased significantly from 2.0% (26/1,295) to 0.7% (9/1,281) of MRSA (P<0.01).

Western Australia

Figure 24: Annual number of Micro-alert B and Micro-alert C MRSA, Western Australia 2018/2019 to 2022/2023

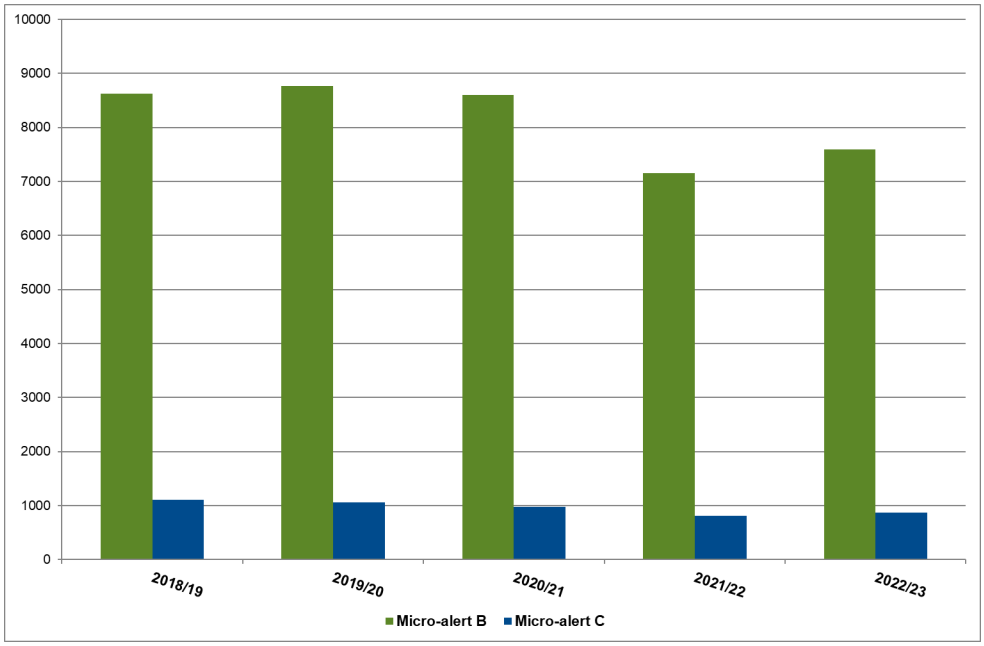


Figure 25: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Western Australia 2018/2019 to 2022/2023

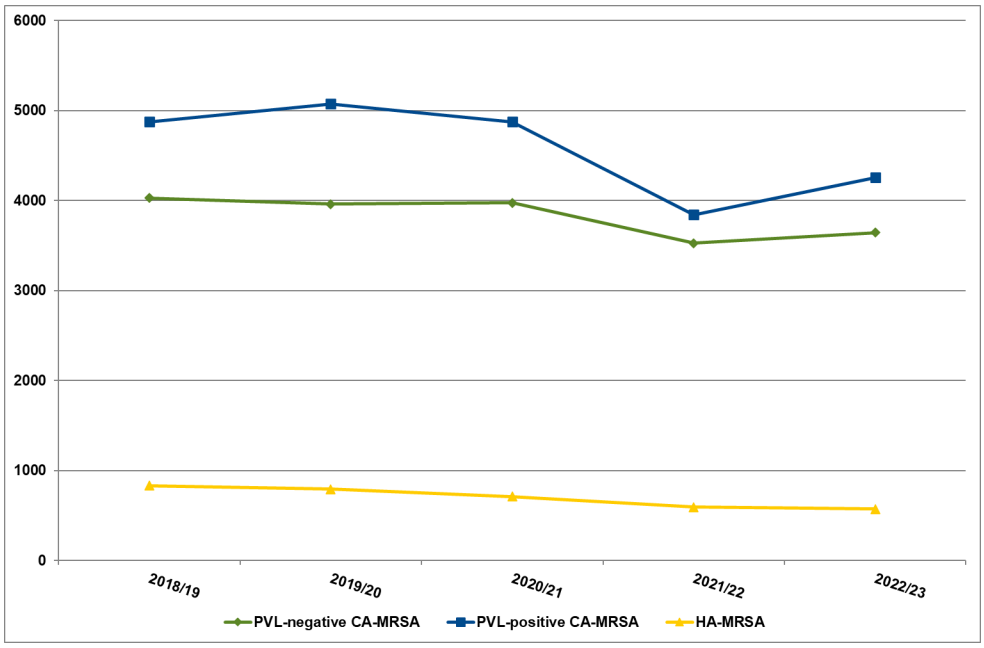
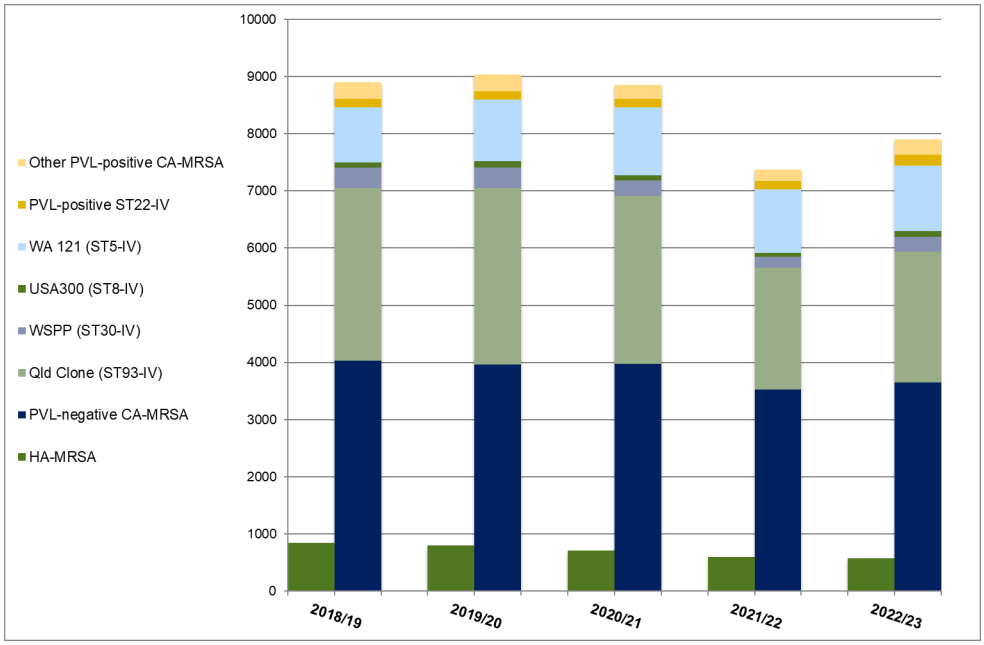


Figure 26: Annual number of CA-MRSA and HA-MRSA, Western Australia 2018/2019 to 2022/2023



Perth Metropolitan Health Region

Figure 27: Annual number of Micro-alert B and Micro-alert C MRSA, Perth Metropolitan Health Region 2018/2019 to 2022/2023

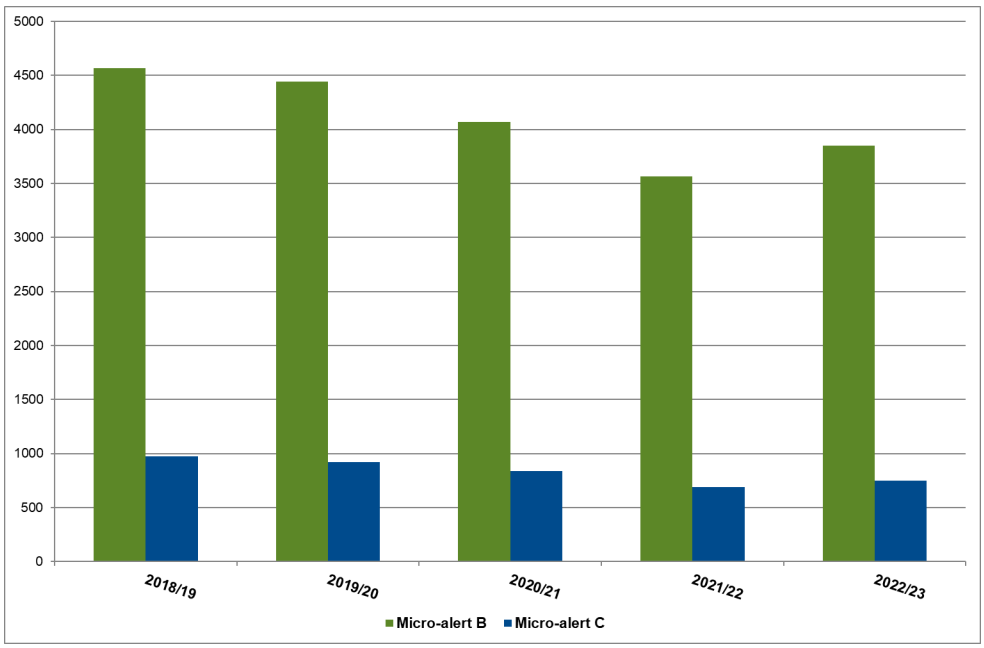


Figure 28: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Perth Metropolitan Health Region 2018/2019 to 2022/2023

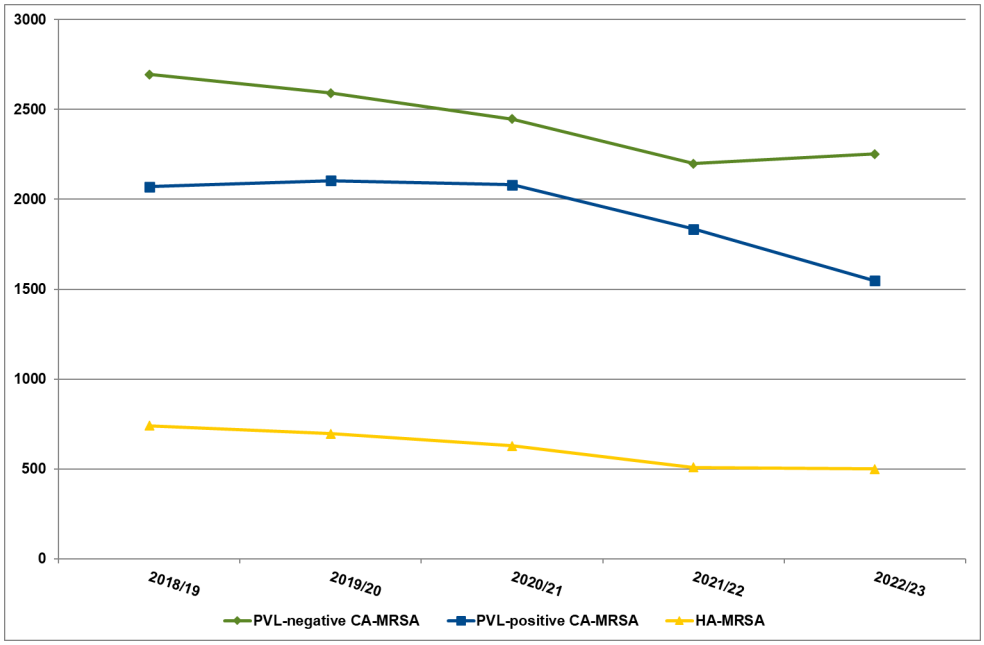
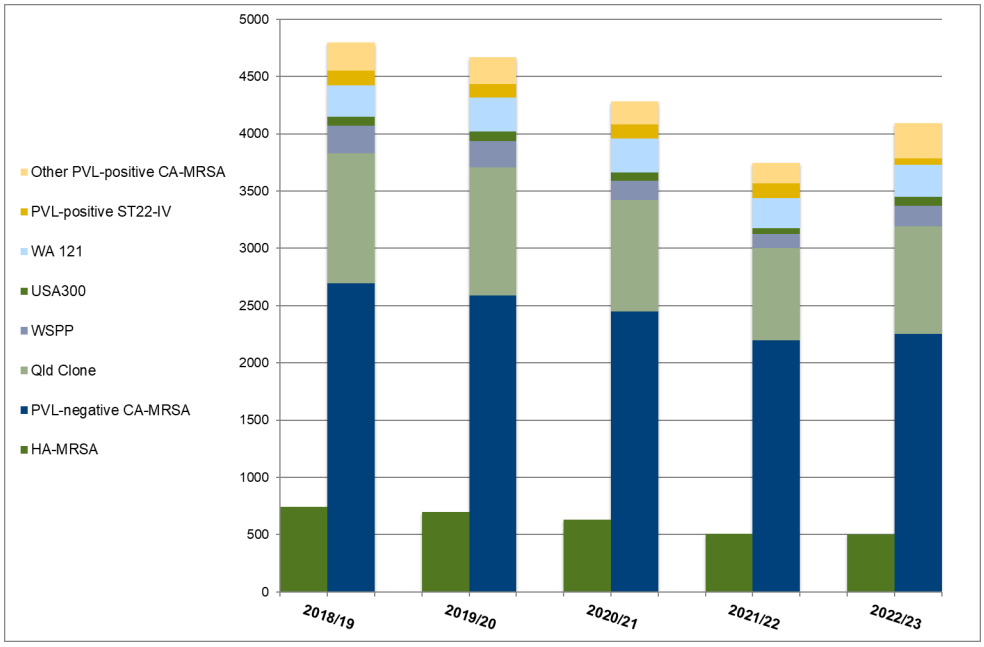


Figure 29: Annual number of CA-MRSA and HA-MRSA, Perth Metropolitan Health Region 2018/2019 to 2022/2023



South West Health Region

Figure 30: Annual number of Micro-alert B and Micro-alert C MRSA, South West Health Region 2018/2019 to 2022/2023

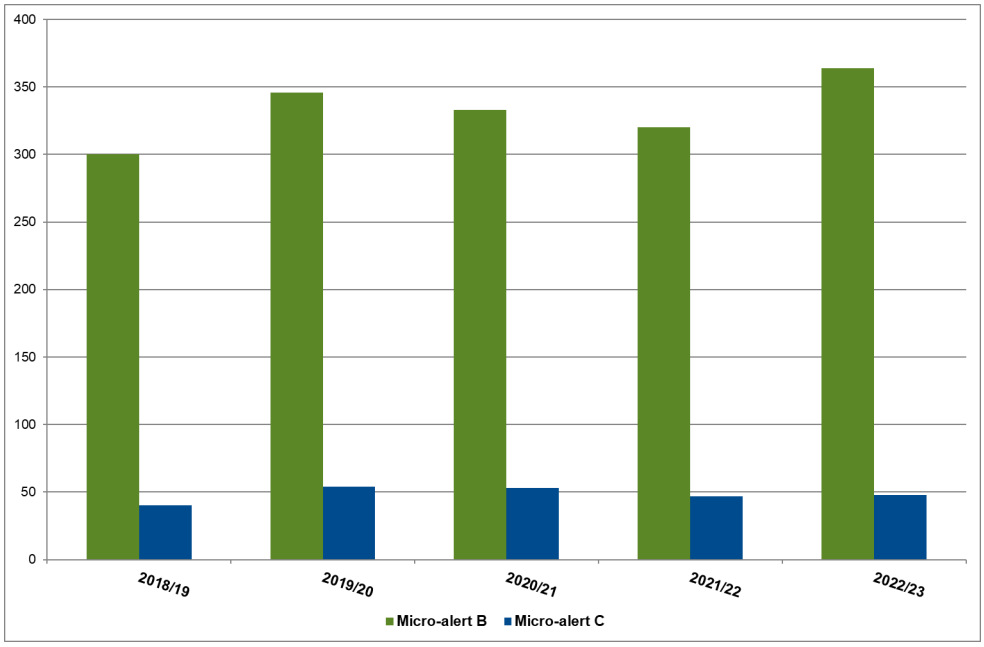


Figure 31: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, South West Health Region 2018/2019 to 2022/2023

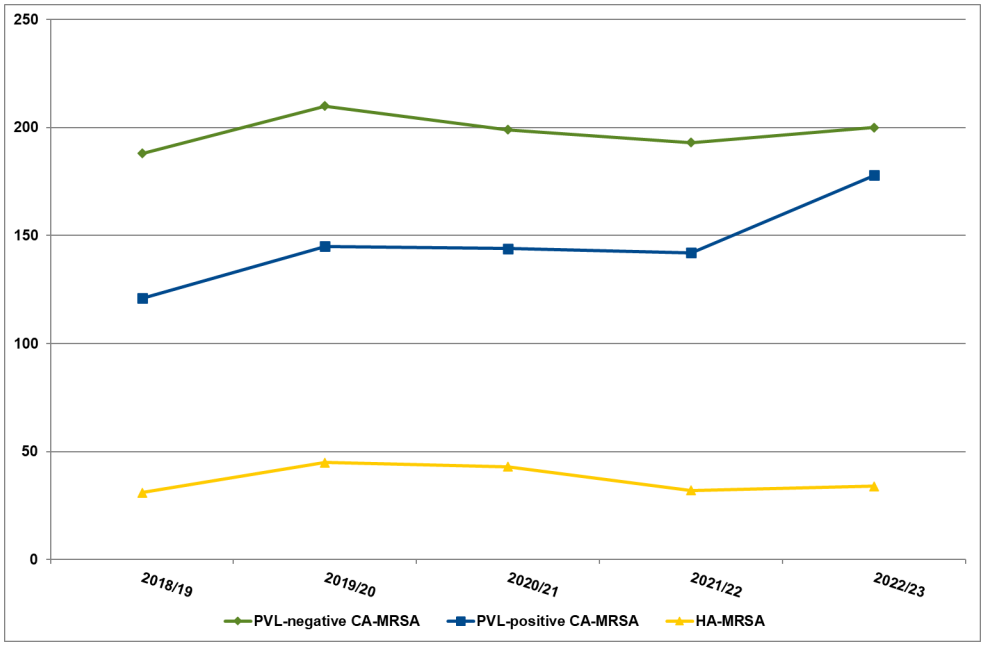
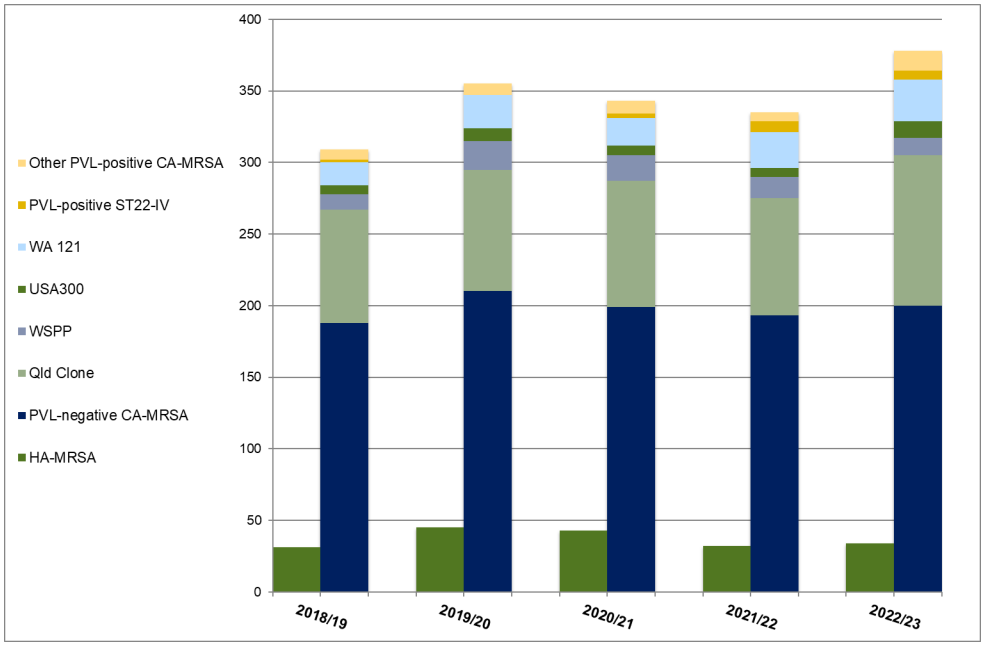


Figure 32: Annual number of CA-MRSA and HA-MRSA, South West Health Region 2018/2019 to 2022/2023



Great Southern Health Region

Figure 33: Annual number of Micro-alert B and Micro-alert C MRSA, Great Southern Health Region 2018/2019 to 2022/2023

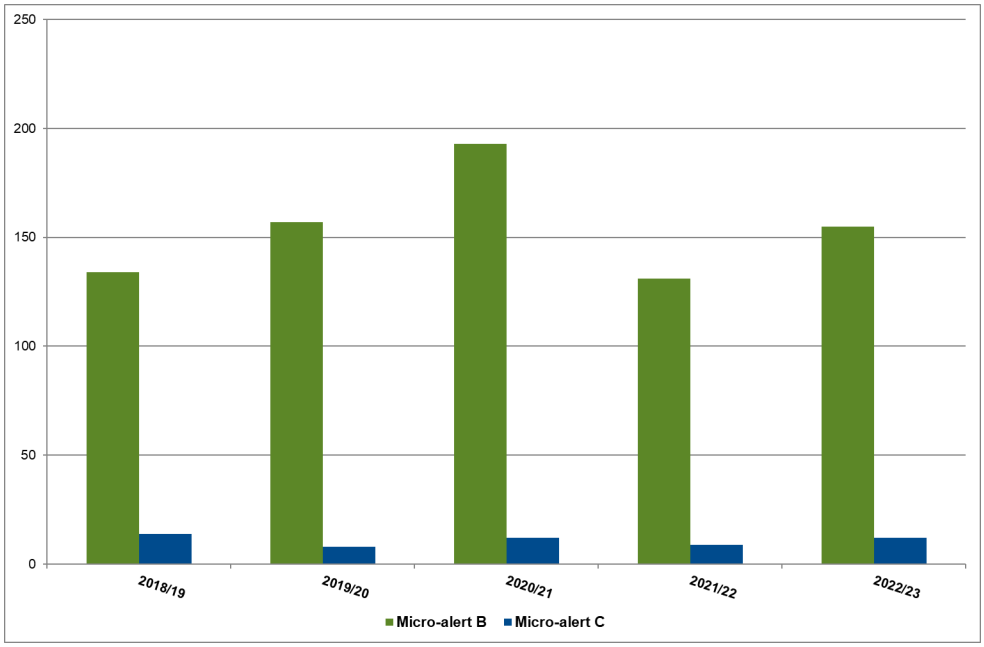


Figure 34: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Great Southern Health Region 2018/2019 to 2022/2023

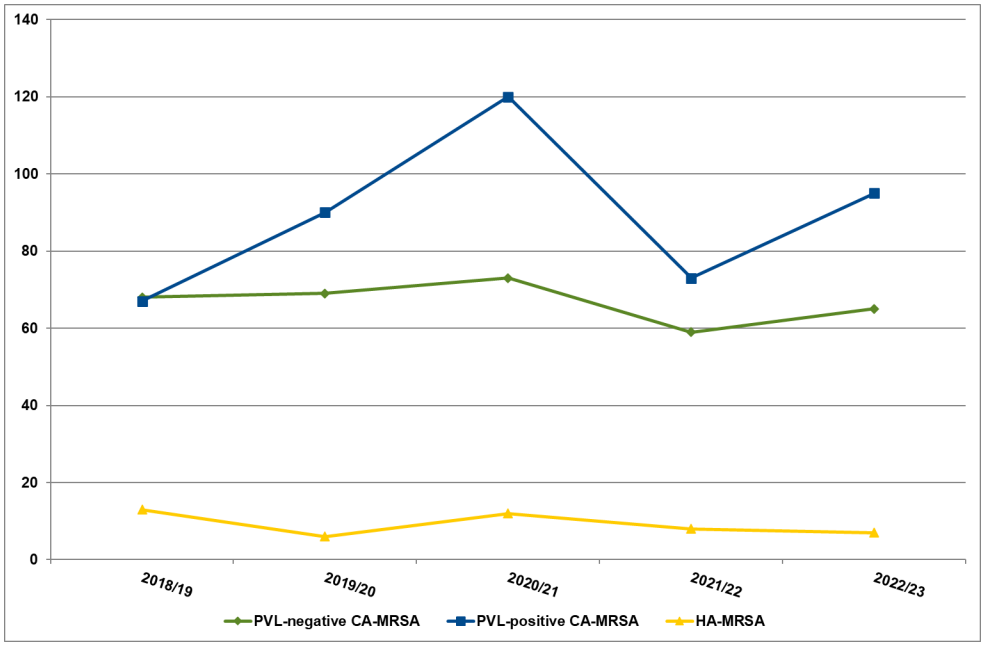
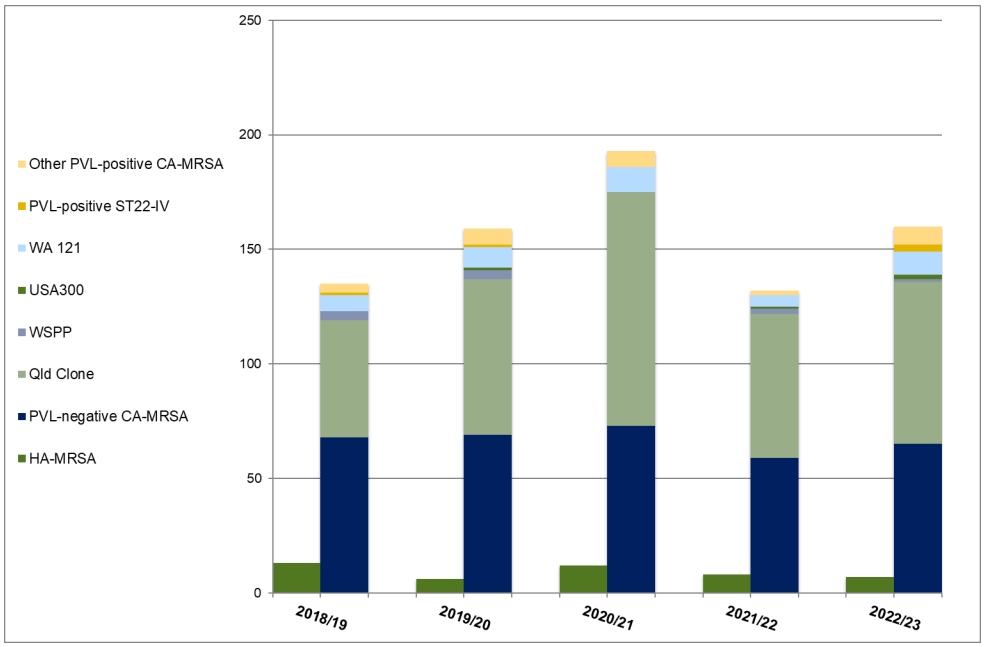


Figure 35: Annual number of CA-MRSA and HA-MRSA, Great Southern Health Region 2018/2019 to 2022/2023



Midwest Health Region

Figure 36: Annual number of Micro-alert B and Micro-alert C MRSA, Midwest Health Region 2018/2019 to 2022/2023

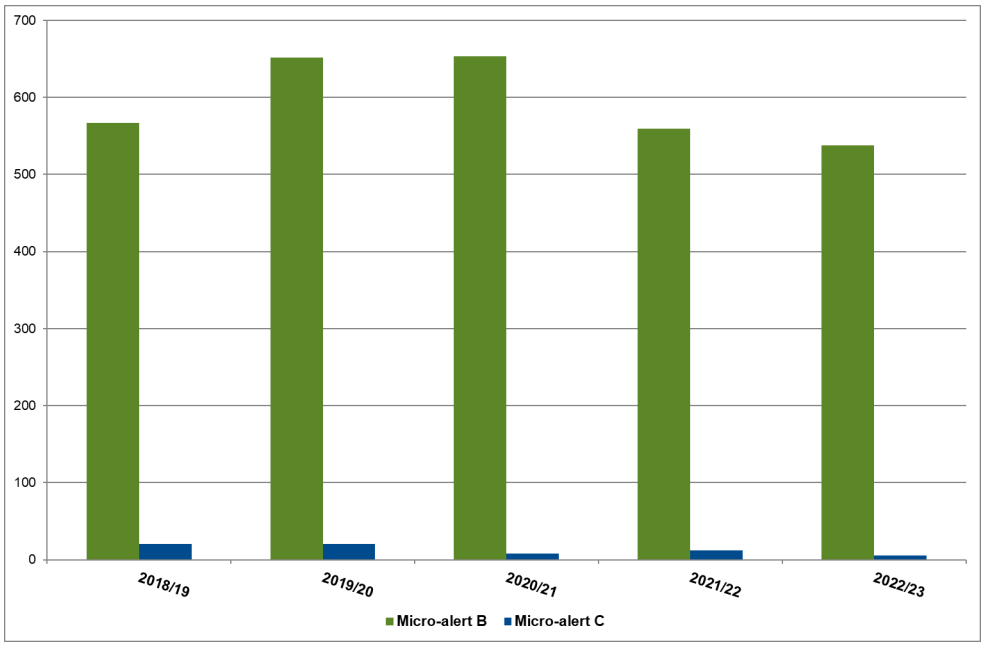


Figure 37: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Midwest Health Region 2018/2019 to 2022/2023

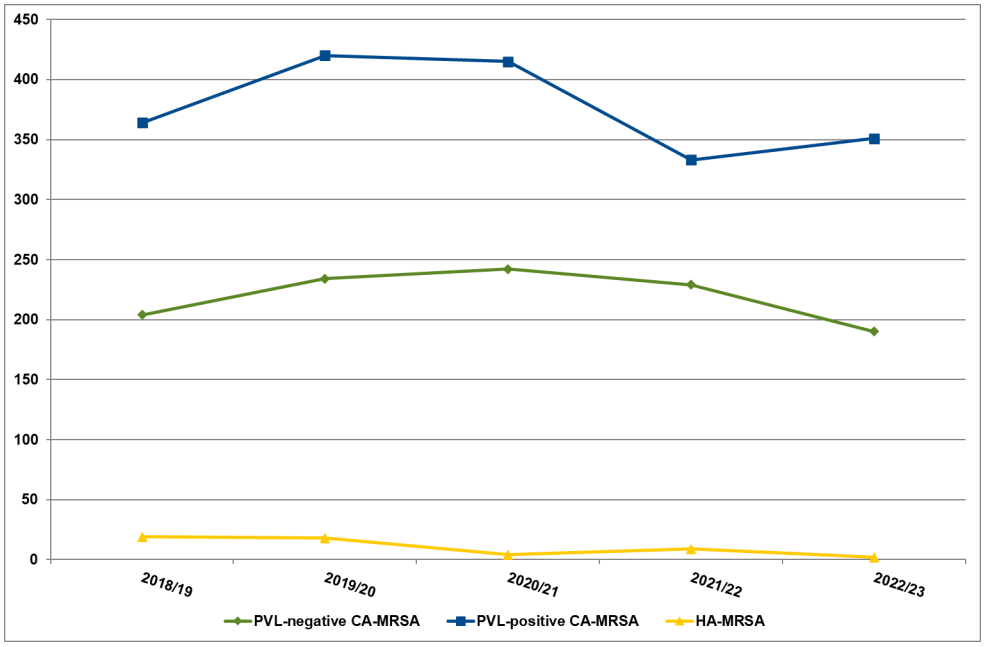
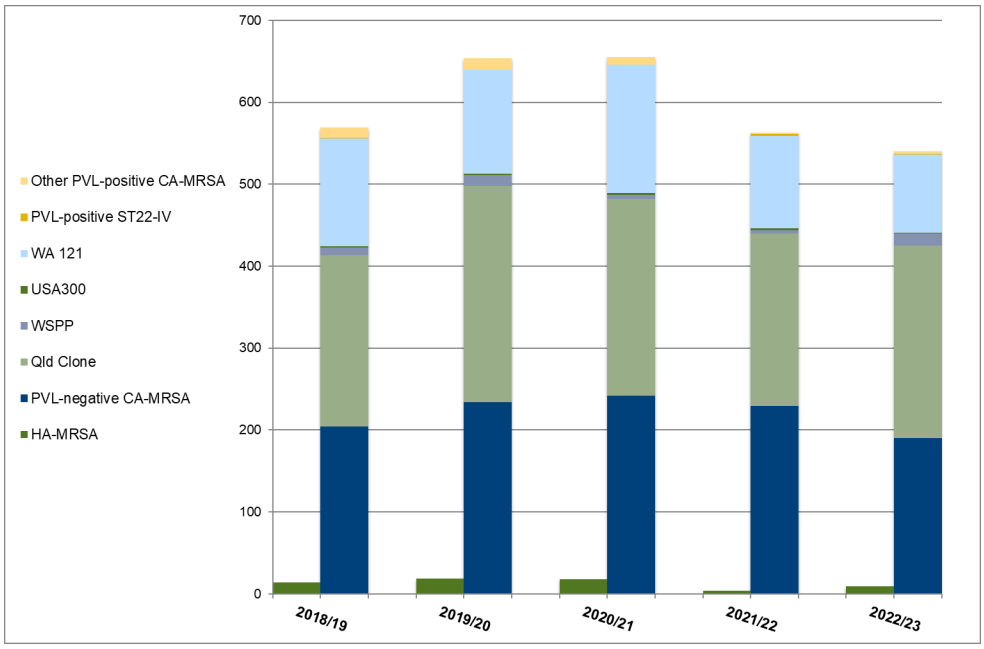


Figure 38: Annual number of CA-MRSA and HA-MRSA, Midwest Health Region 2018/2019 to 2022/2023



Wheatbelt Health Region

Figure 39: Annual number of Micro-alert B and Micro-alert C MRSA, Wheatbelt Health Region 2018/2019 to 2022/2023

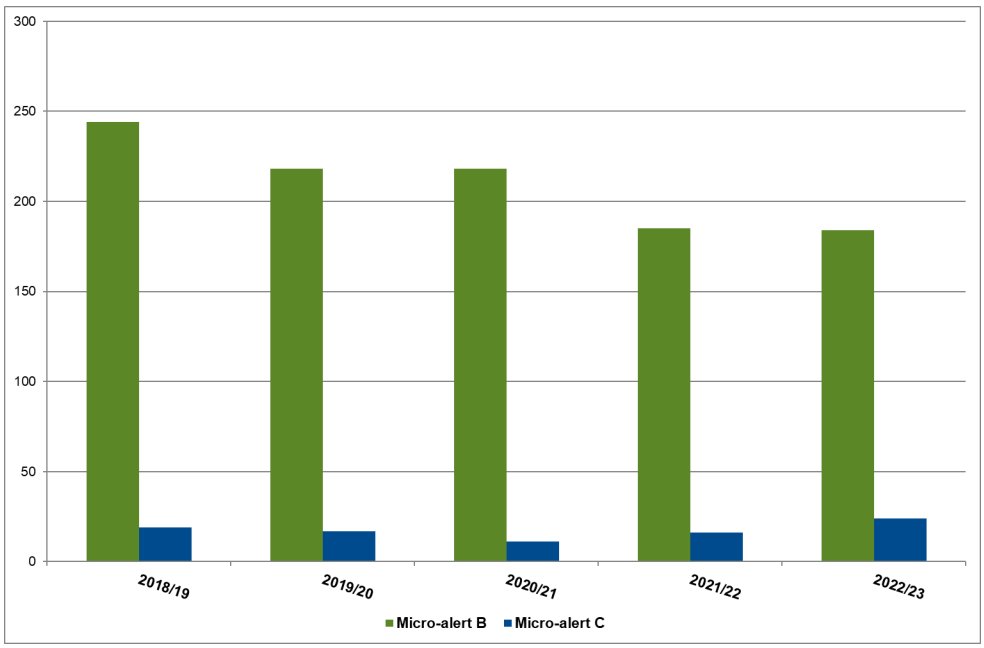


Figure 40: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Wheatbelt Health Region 2018/2019 to 2022/2023

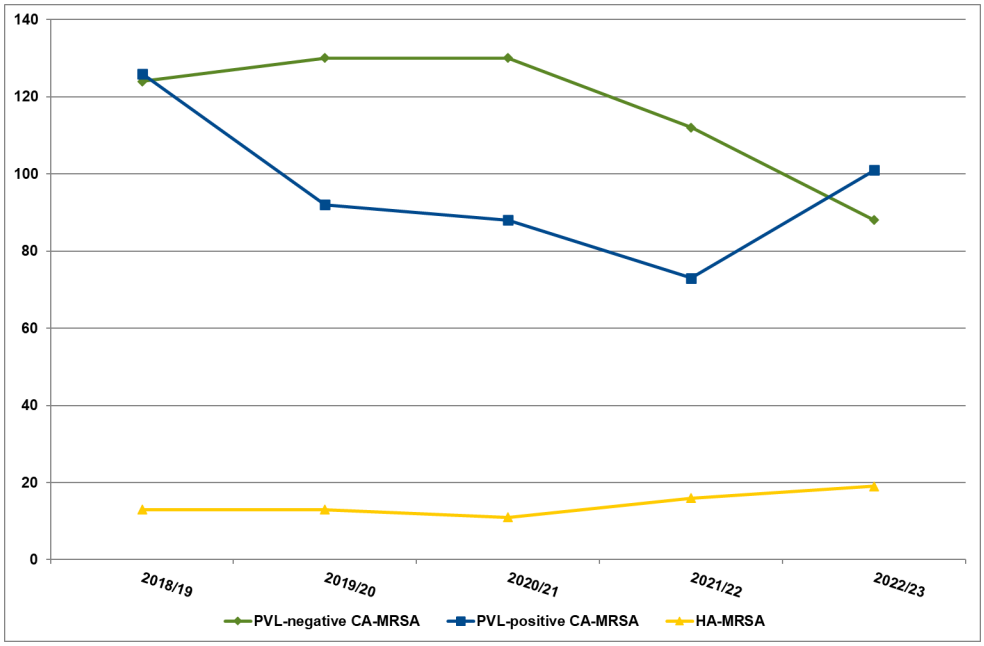
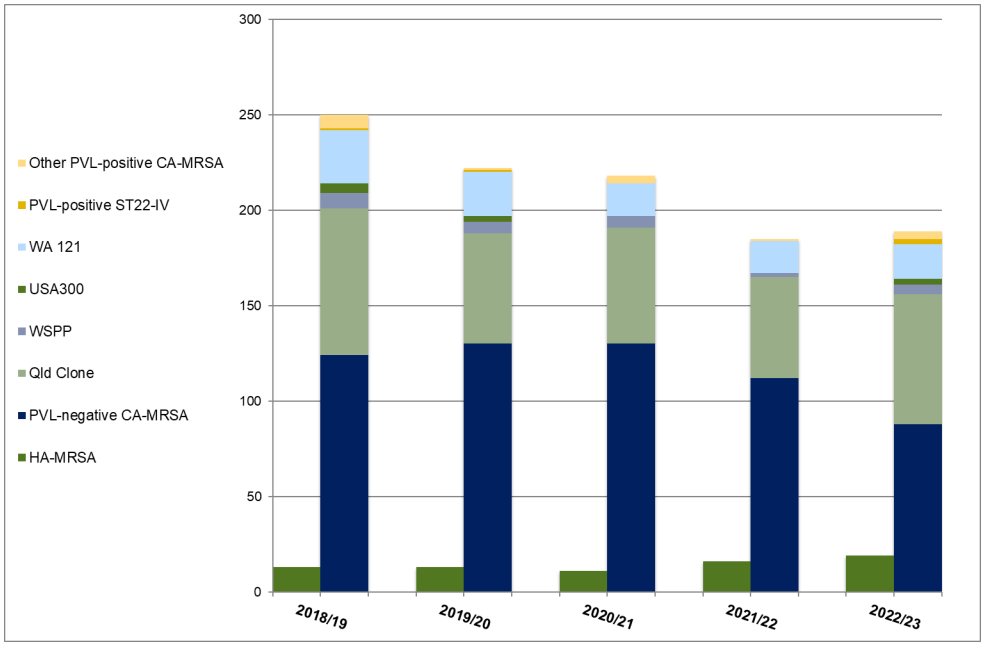


Figure 41: Annual number of CA-MRSA and HA-MRSA, Wheatbelt Health Region 2018/2019 to 2022/2023



Goldfields Health Region

Figure 42: Annual number of Micro-alert B and Micro-alert C MRSA, Goldfields Health Region 2018/2019 to 2022/2023

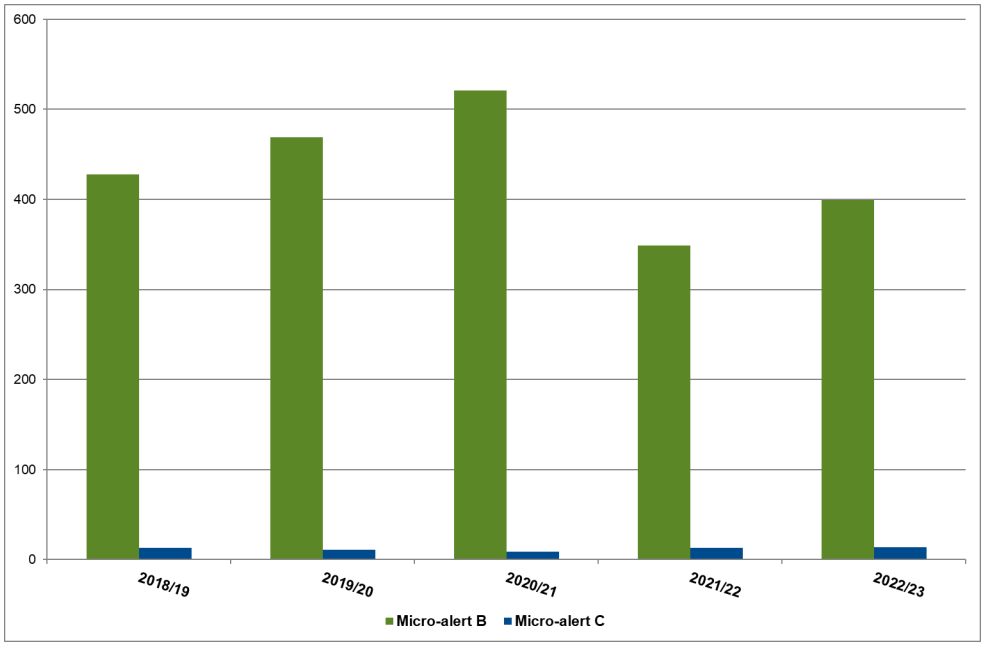


Figure 43: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Goldfields Health Region 2018/2019 to 2022/2023

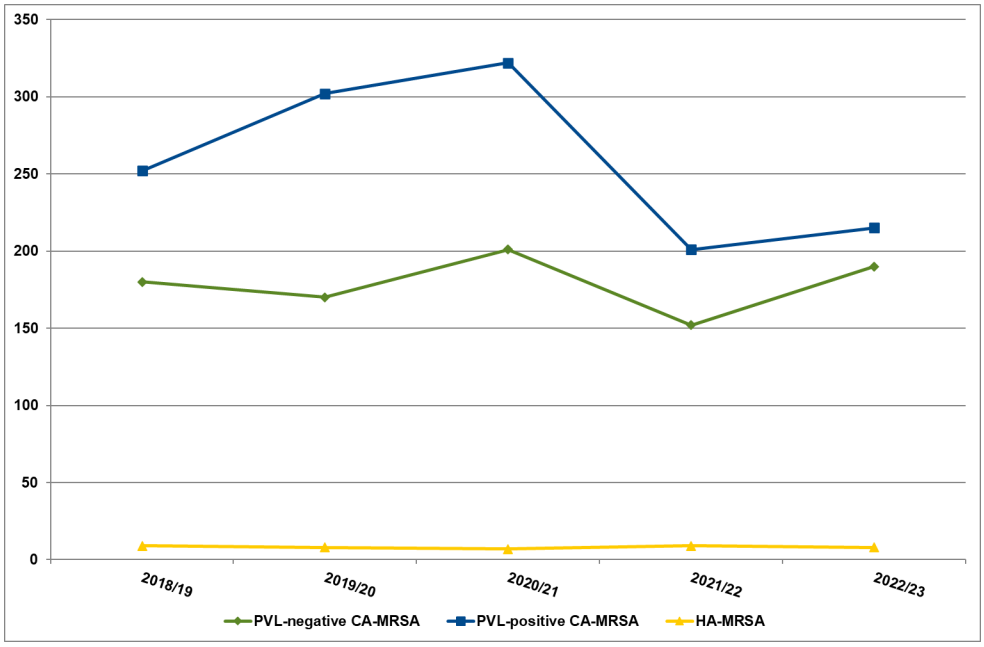
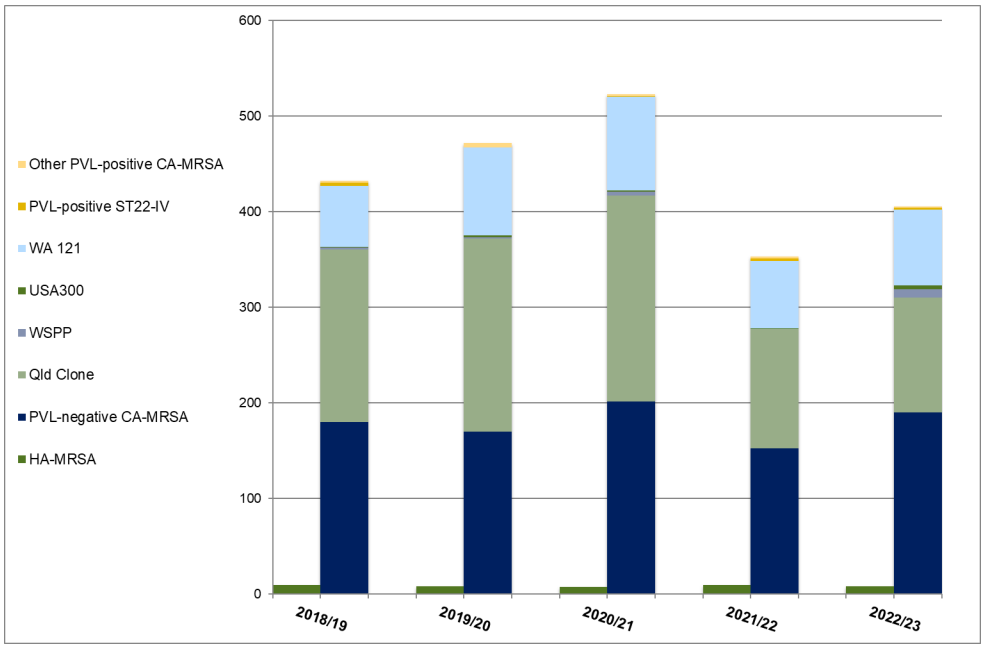


Figure 44: Annual number of CA-MRSA and HA-MRSA, Goldfields Health Region 2018/2019 to 2022/2023



Pilbara Health Region

Figure 45: Annual number of Micro-alert B and Micro-alert C MRSA, Pilbara Health Region 2018/2019 to 2022/2023

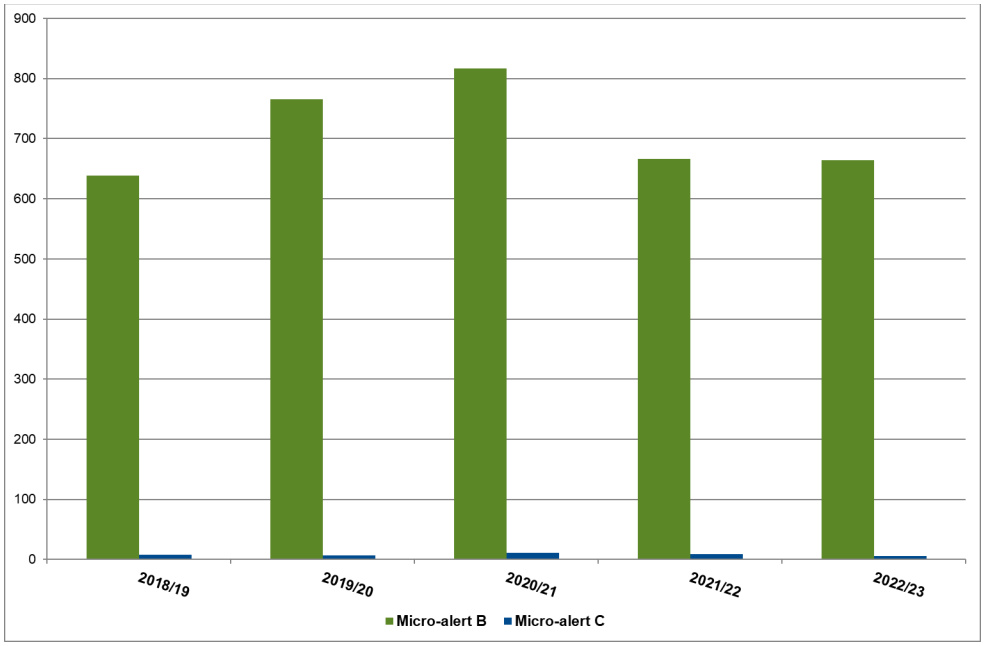


Figure 46: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Pilbara Health Region 2018/2019 to 2022/2023

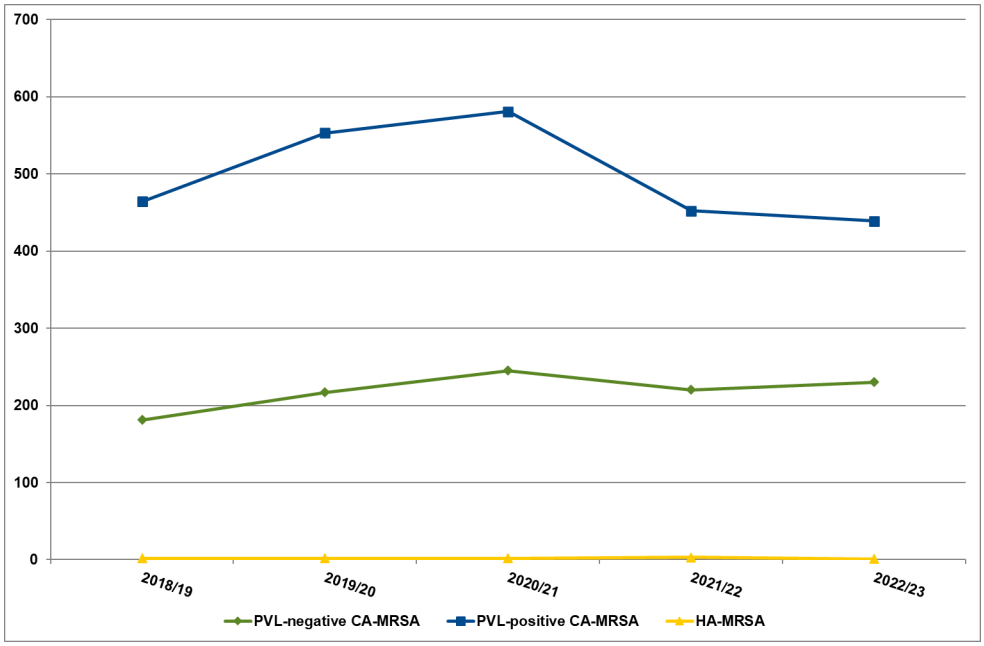
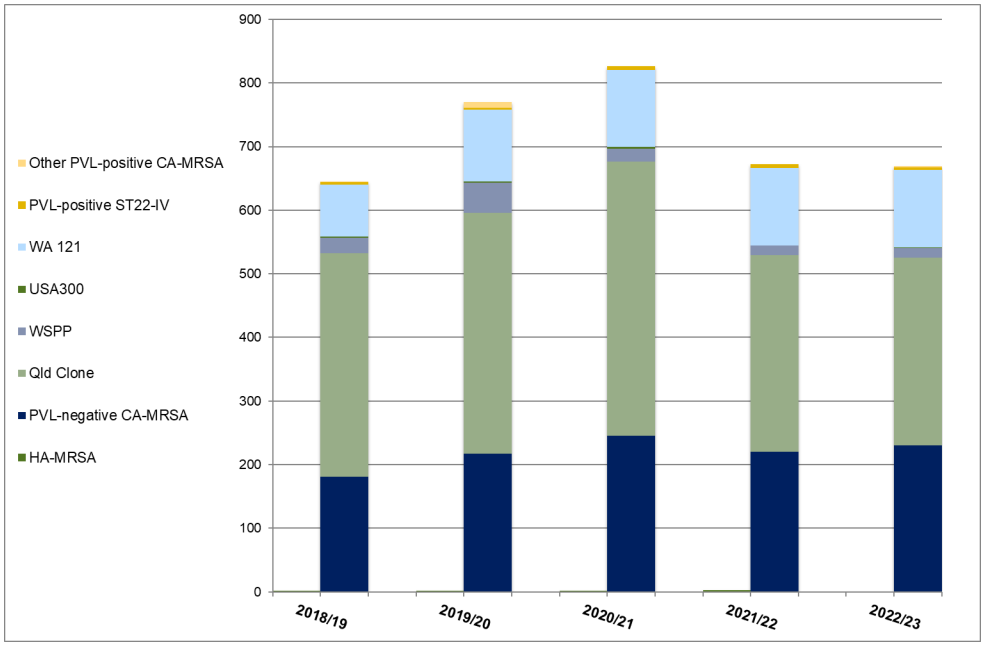


Figure 47: Annual number of CA-MRSA and HA-MRSA, Pilbara Health Region 2018/2019 to 2022/2023



Kimberley Health Region

Figure 48: Annual number of Micro-alert B and Micro-alert C MRSA, Kimberley Health Region 2018/2019 to 2022/2023

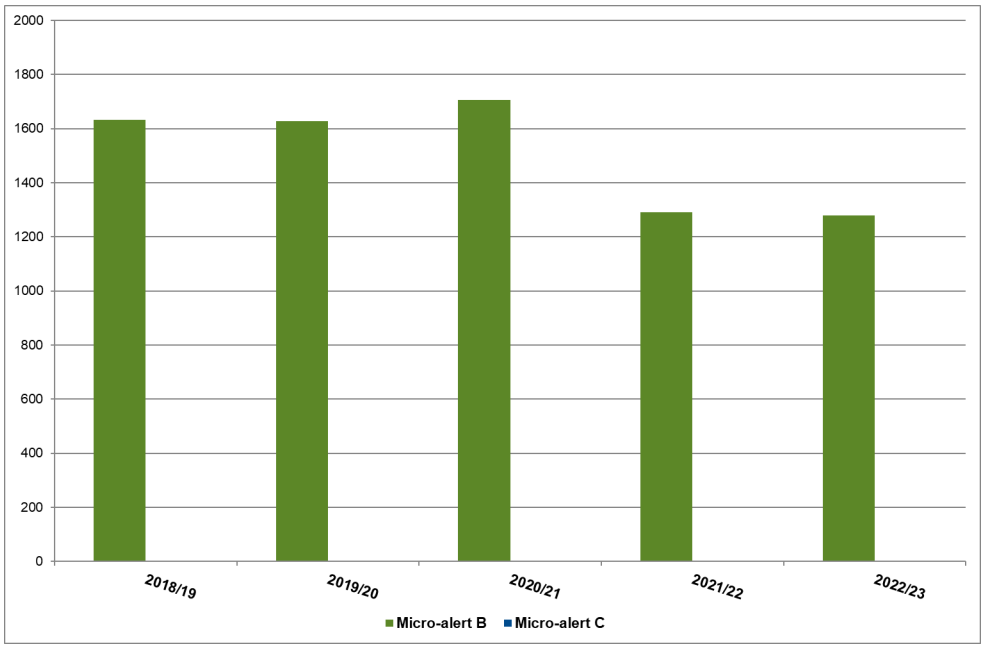


Figure 49: Annual number of known PVL-positive and –negative CA-MRSA and HA-MRSA, Kimberley Health Region 2018/2019 to 2022/2023

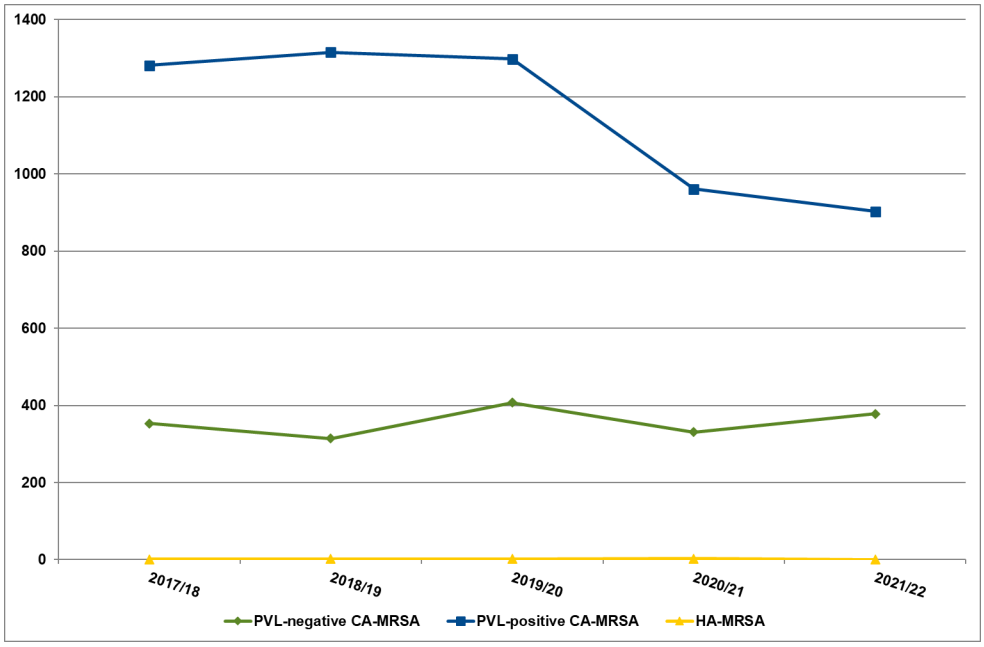
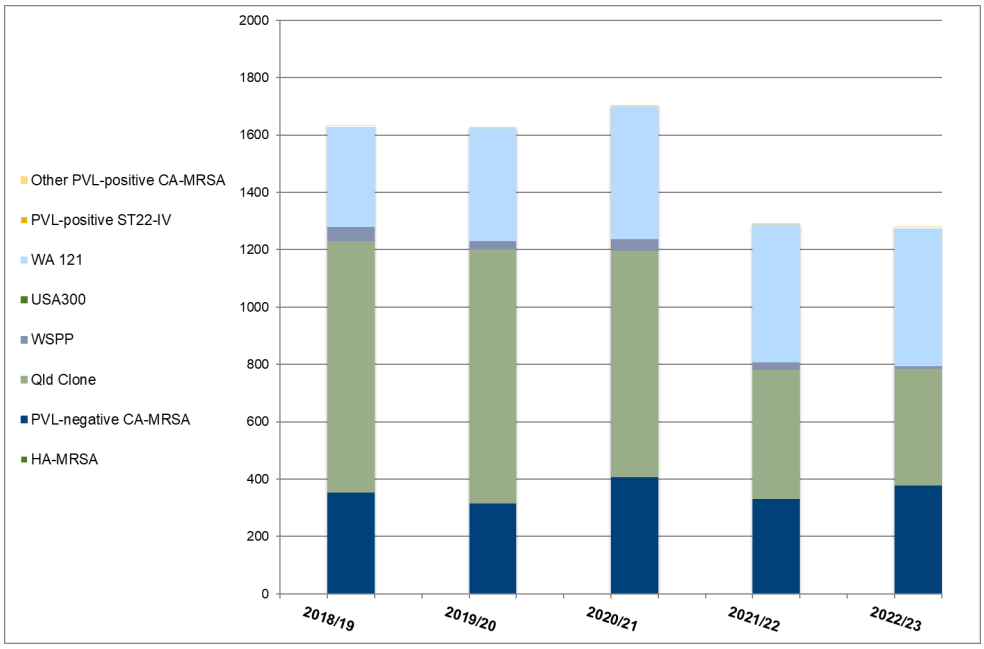


Figure 50: Annual number of CA-MRSA and HA-MRSA, Kimberley Health Region 2018/2019 to 2022/2023



11 Acknowledgements

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- The Department of Health, Western Australia
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